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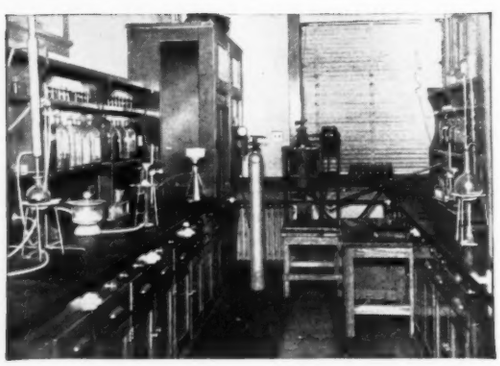

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THE Petroleum Engineer

OCTOBER 1935

VOLUME VII NUMBER 1

A MAGAZINE OF METHODS FOR OPERATING MEN

This Issue Contains

Page

DRILLING AND PRODUCTION

Handling Small Production by Gas-Lift—Oklahoma City Field - - - 25
By S. F. Shaw

Completing Wells with Rotary in Low-Pressure Fields - - - - - - - 31
By Wallace A. Sawdon

Pressure Drilling in Oklahoma - - - - - - - - - - - - - - - 42
By John S. Ross

Resistance Pyrometer for Measuring Subsurface Temperatures - - - 54
By W. C. Lane

Elements of Applied Petroleum Production (Article 24) - - - - - - 76
By K. C. Sclater

REFINING AND NATURAL GASOLINE MANUFACTURE

Absorption Practice in a Large Gasoline Plant - - - - - - - - - - 34
By J. C. Albright

The Manufacture, Packaging, and Shipping of Oxidized Asphalts (Article 9) - 38
By Charles J. Holland

Elements of Applied Petroleum Refining (Article 24) - - - - - - - 79
By W. L. Nelson

OIL AND GAS TRANSPORTATION

Construction Methods Employed on 109-Mile Gas Line - - - - - - - 28
By Frank H. Love

Calculations for and Methods of Design of Slide Rule for Use in Oil Pipeline Problems - 51
By L. V. W. Clark, R. Fallah, and A. W. Nash

Elements of Applied Petroleum Pipe Line Transportation (Article 15) 85
By C. E. Main, Sr.

Checking Condition of Oil in Crankcase - - - - - - - - - - - - 102
By Elton Sterrett

GENERAL

Management Problems of Company Camps - - - - - - - - - - - - 94
By F. B. Taylor

California Making Elaborate Plans for A.P.I. Meeting - - - - - - - 48

REGULAR DEPARTMENTS

The Course of Oil - 15
Highlights in Oildom - - - - - - - - - - - - - - - - - - - 17
Progress of Major Pipe Line Work - - - - - - - - - - - - - - 18
Latest Activities in the Oil Fields - - - - - - - - - - - - 20 and 21
The Month's Activities in Refining - - - - - - - - - - - - - - 22
New Petroleum Equipment - - - - - - - - 58, 60, 62, 63, 64, and 65
Pictorial Petroleum - 67
Laugh With Barney - 91
Running Tour With Men in the Industry - - - - - - - - - - - - 92

Meetings

American Association of Petroleum Geologists, Mid-Year Meeting—October 16 and 17, Mexico City, Mexico.

•

American Association of Petroleum Geologists, San Antonio Section (San Antonio Geological Society, Seventh Annual Meeting) — October 16 and 17, Mexico City, Mexico.

•

Independent Petroleum Association of America, Annual Meeting — November 4 and 5, Adolphus and Baker Hotels, Dallas, Texas. (See Page 99).

•

California Natural Gasoline Association—November 7, Richfield Building, Los Angeles.

•

American Petroleum Institute, Sixteenth Annual Meeting — November 11, 12, 13, and 14, Biltmore Hotel, Los Angeles, California.

•

International Acetylene Association —November 12, 13, 14, and 15, Hotel Cleveland, Cleveland, Ohio.

•

International Petroleum Exposition —May 16-23, 1936, Tulsa, Oklahoma.

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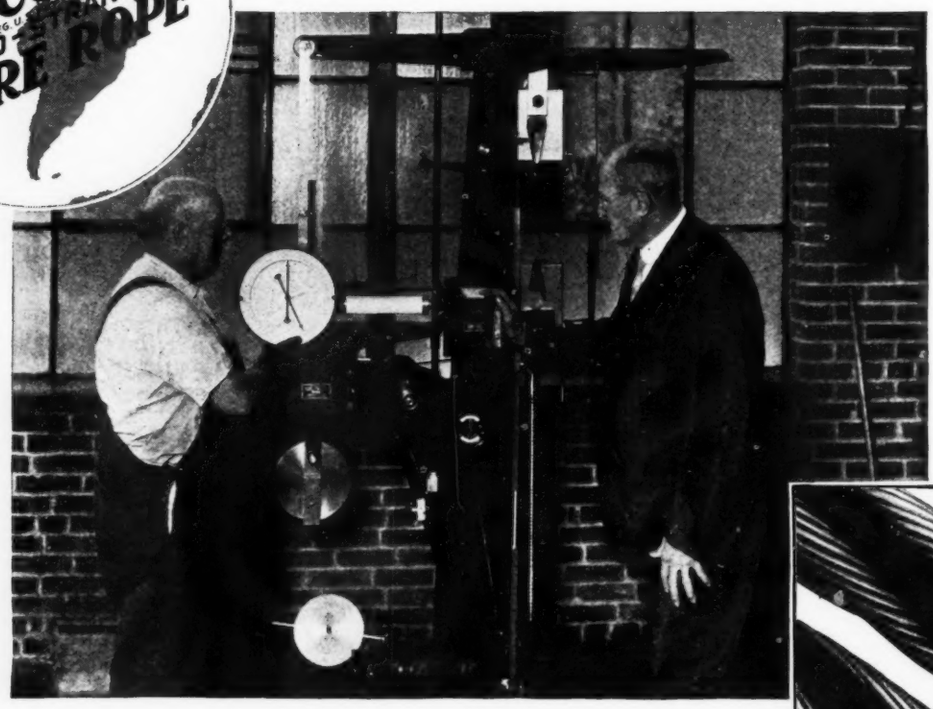

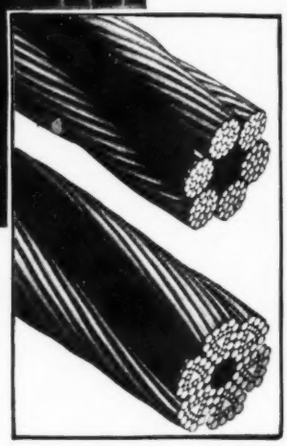

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The Course of Oil

By K. C. SCLATER

Keeping Abreast of Developments

Two important events of interest to be held next month are the Sixteenth Annual Meeting of the American Petroleum Institute at Los Angeles, California, and the Sixth Annual Meeting of the Independent Petroleum Association of America at Dallas, Texas. The Dallas meeting will take place November 4 and 5, and the Los Angeles meeting November 11 to 14.

A highlight of interest at both gatherings will be an address on the Interstate Oil Compact by Governor E. W. Marland of Oklahoma, chairman of the Interstate Oil Compact Commission. Though it has barely entered on its duties, the work of the Compact Commission has already paved the way for the constructive handling of common problems among the oil-producing states.

The Independent Petroleum Association has pledged the Compact Commission its support, and by inviting the officials of the regulatory bodies of all oil-producing states to its annual meeting is providing a rare opportunity for these officials to discuss their mutual problems. This spirit of coöperation is encouraging.

Officials in all branches of the petroleum industry will find much of interest at the sessions to be held in Los Angeles. Attendance at the Annual Meeting of the American Petroleum Institute is an effective means of keeping abreast of developments in and affecting the industry.

Consider Ultimate Results

Inclusion of acreage for determining well allowables in the East Texas field was suggested in a recent court ruling. A group of operators in that field has shown violent opposition to consideration of acreage in any form with the plea that it will work a hardship on many of the small operators. It is hard to reconcile the viewpoints of opponents to the court's suggestion on the grounds that it will be a hardship on the small operators. It is still harder to reconcile the viewpoint of those opponents who profess to have the interests of the state and the public at heart.

Petroleum engineering knowledge does show that an equitable method for prorating wells should include not only acreage but also other subsurface considerations. There is no doubt in the minds of the majority of the industry that those operators advocating the inclusion of an acreage factor in a plan of proration in the East Texas field are sincere in their belief that it will be to the ultimate benefit of every operator in that field and result in more economical production of oil therefrom.

The trend of underground conditions in the East Texas field indicates that the slow rate at which the field is being produced will result in a high ultimate recovery. Increasing the number of wells may result in a still higher ultimate recovery but whether such increased recovery is enough to justify the drilling of a great number of wells is in doubt. There is an economic limit to drilling, beyond which the cost of obtaining the oil will become excessive and can only result in a higher cost to the consuming public. It also must not be forgotten that increasing the number of wells must inevitably lead to a much greater allowable for the field, and producing the field at a much greater rate than at present, experience tells us, will lead to underground physical waste and be to the ultimate detriment of the field.

Those opponents of the acreage factor who have the interest of the state and public at heart may by their very action be instrumental in increasing the ultimate cost of petroleum to the consuming public and causing a loss in ultimate revenue to the state.

Interstate Oil Compact Commission

No body of officials in the history of the industry has had such far-reaching possibilities for improving the petroleum industry as that of the Interstate Oil Compact Commission.

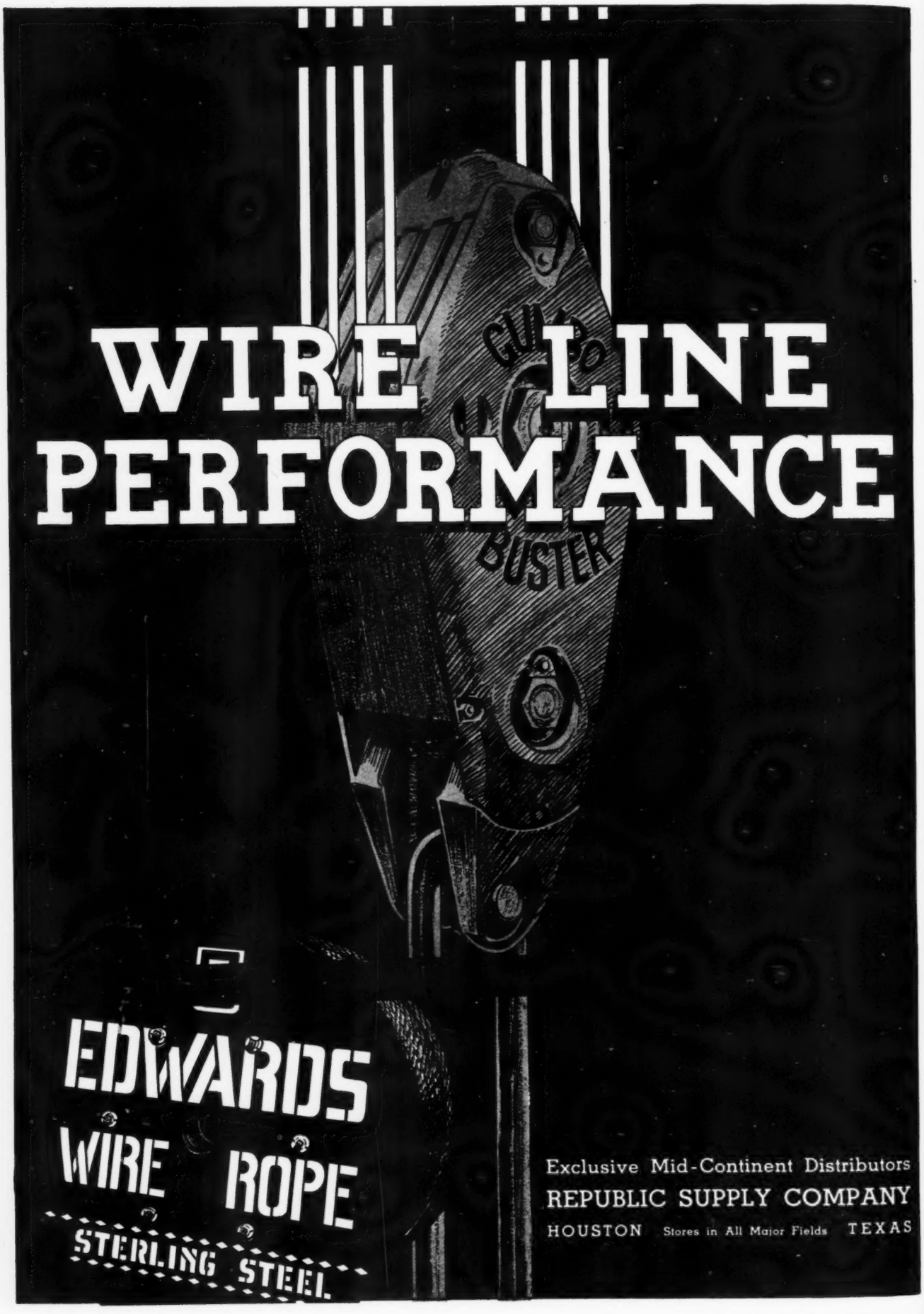
On October 11, it met in a brief session during which it adopted by-laws, one of which provided for acceptance of U. S. Bureau of Mines allocation recommendations by various state proration agencies until such time as the Commission deems otherwise. Four committees were appointed, namely: (1) Conservation, (2) Coördination, (3) Consumption, and (4) Imports and Exports.

The committee on conservation will study improved methods of conservation, statutes of states and methods of administering them. The committee on coördination will determine aggregate potential production of oil states, percentage of crude being produced, estimate proven reserves, make reports periodically, and recommend plans for uniform determination of potentials and elimination of incorrect estimates. The committee on consumption will study methods of determining demand, including those used by the U. S. Bureau of Mines, in an effort to promote accuracy in estimating demand. In the meantime, the committee on imports and exports will study data similar to the consumption committee.

If agreement among the oil-producing states can be reached on these items, the Commission will have gone a long way toward fulfilling its purpose, that of aiding in the conservation of national resources of oil and gas.

Gasoline From Refinery Waste

Making premium grade gasoline from refinery and natural gases by the Polymerization Process, the exploitation of which on a large commercial scale has recently been announced, calls attention to the fact that the quantity of available motor fuel from crude petroleum has again been augmented, this time by utilizing waste products of refining.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« « « HIGHLIGHTS IN OILDOM » » »

Potential Tests Required on All O. C. Wells

Conservation Officer W. J. Armstrong is urging operators of Wilcox zone wells in Oklahoma City field without new potentials for the six months' period beginning with October 1, to have their wells tested during the current month. Orders of the Oklahoma Corporation Commission to re-determine the potentials of the Wilcox zone give operators an option of taking either an open flow gauge or a 70 percent decline, he said. All wells on which potentials were not taken as of October 1 were declined automatically for October on the 70 percent basis or a fractional part thereof.

The commission's orders also provide that wells taking the decline must take production tests and that no well can produce after November 1 until such test is taken.

The potentials of all old wells that heretofore have had no potential or production tests, where such potentials are taken in October, will be effective as of October 1.

●

Bill Would Increase Texas Crude Tax

A bill authorizing a 25 percent increase in the gross production tax in Texas has been approved by the House Committee on Revenue. If passed the tax on crude oil will be two and one-half cents per bbl. until the price exceeds $1.00, and two and one-half percent of the value thereafter.

The measure, as originally introduced, was intended to advance the tax on crude to six cents per bbl. and six percent of the value when oil was worth more than $1.00. It was referred to a sub-committee and the report of that body provided for a graduated tax based on the number of bbl. produced daily from the individual well. Oil from wells producing ten bbl. per day or less would be taxed two cents per bbl. or two percent of the value after oil reached $1.00. Oil from wells producing 10 to 20 bbl. per day would be taxed three cents per bbl. or three percent of the value after the price reached $1.00. From wells producing in excess of 20 bbl. the tax would be four cents per bbl. or four percent of the value after the price reached $1.00. Protests by stripper well operators, however, who asserted that the graduated scale would ruin the stripper areas because a separate tank to measure production from each well would be required, undoubtedly influenced the committee to abandon the graduated tax.

Twenty-five percent of the tax would be diverted to the school fund, and 75 percent to the fund for old age pensions, according to the provisions of the bill.

●

California Continues Curtailment Efforts

With all previous plans for controlling California's crude oil production admittedly ineffective, the most recent step taken toward solving the state's problem has been the formation of an emergency advisory board of independent oil producers. Thus the task of keeping production and demand balanced in California has been taken over by the independents, as it is generally known that the major companies are willing to cooperate in any equitable curtailment program. The independent producers' board is composed of Ralph B. Lloyd, chairman; A. T. Jergins, R. A. Broomfield, J. W. Wood, Dana Hogan, Lawrence E. Doan, and J. J. Doyle.

The most recent development in the situation was the exempting by the board of six fields from further curtailment during the present year because the decline apparent in the state's oil fields and the lack of discovery of new fields is expected shortly to bring production in line with consumption. The full text of the committee's resolution follows:

"Resolved that from a review of demand data it now appears that California must at some future time emerge from curtailment by the successful exemption of fields from curtailment since the decline now apparent in oil fields will shortly bring the total of production in the state to the figure for the total demand.

"Following this principle and because of the large number of operators involved, the number of single well operators, encroachment of water, drainage difficulties, complexity of operating conditions, and for the protection of the large number of employees, Long Beach, Santa Fe Springs, Huntington Beach, Playa Del Rey, Alamitos Heights, and Mountain View fields are relieved during the period from October 1 to December 31, inclusive, from any marked curtailment."

The board has approved a daily quota of 580,700 bbl. for the state during the remainder of the year. This is substantially in excess of the allowable previously recommended, but the emergency advisory committee has approved it with the declaration that for the first time in five years crude and refined oil stocks are down to economic levels and that production during the remainder of the year must be limited only by market demand.

●

New Method of Completing Wells

A new method of completing wells has been developed by the California Company and is being used in the South Ward field of Texas with interesting results. The sand is first drilled into with oil under pressure, then shot with approximately 300 quarts of nitro, after which gas is injected through the drill stem. This procedure serves to clean the hole thoroughly, leaving nothing in the sand to seal off the oil.

A year ago the California Company's No. 6 York was completed, before the new method was developed. It made an initial flow of 593 barrels. A few days ago the same well was recompleted, using the new procedure and flowed 1054 bbl. in 24 hours on a potential test.

PROGRESS OF MAJOR PIPE LINE WORK

THE new pipe line of the Union Gas Company of Canada, Ltd., from the Dawn field to London, Ontario, has been completed, representing the laying of a total of 71¾ miles of pipe of various sizes, including trunk line, city mains, and field lines. Gathering lines in the field consist of 9¾ miles of 8-in. pipe. Forty-eight miles of 10-in. line was laid from the field to London, and an additional three miles of 10-in. was required within the city limits of London to connect with the City Gas Company system. A total of 11 miles of 4-in. and 8-in. mains had to be laid in connection with the distribution system.

Three river crossings were negotiated in the course of the line's construction. The Sydenham River was crossed in Euphemia Township, the Thames River near Delaware, and the Thames again inside the limits of London. Railway crossings were made at four points. A field measuring station was installed at Dawn, as well as a measuring and pressure-control station.

●

The Rodessa Oil and Refining Company may construct a pipe line from Cedar Grove, Louisiana, to the new Rodessa field, a distance of 40 miles, it is stated. Recently the company, of which Martin J. Grogan is president, leased, with option to buy, the refinery of the Crystal Oil and Refining Company at Cedar Grove, a suburb of Shreveport.

●

The Simrall Pipe Line Corporation, in conjunction with the Standard Oil Company of Ohio, is scheduled to start construction the middle of this month on an 8-in. line from the Crystal, Michigan, field to Toledo, Ohio, a distance of 140 miles. The Franklin Tool Company of Mt. Pleasant, Michigan, has been awarded the contract. The line will have an initial capacity of 2000 bbl. of crude daily, and is expected to cost approximately $1,500,000 to construct.

This will be the first pipe line to connect Michigan fields with out-of-state markets and is expected to place crude from that territory on a competitive basis with that from the Mid-Continent.

●

The Consumers Power Company has filed application with the Michigan Public Utilities Commission for construction of a 70-mile, 8-in. natural gas line from the Millbrook field of Mecosta County, Michigan, to Lansing.

●

A 45-mile, 22-in. gas line is being laid from Milpitas, California, to San Francisco, for the Pacific Gas and Electric Company. The Youdall Construction Company of San Francisco are the general contractors, and H. C. Price, Inc., of Bartlesville, Oklahoma, are doing the electric welding on the project.

●

The Kaw Pipe Line Company has been organized for the construction and operation of an 8-in. line from Chase, Kansas, to Russell County, Kansas, the project being undertaken by the Empire Pipe Line Company, the Texas Pipe Line Company, and the Standish Pipe Line Company. Construction work already is under way. This project, together with that of the Socony-Vacuum Corporation, White Eagle Division, whose line will extend from Burrton to Chase, will provide additional pipe line facilities for Western Kansas that are greatly needed. White Eagle already has an 8-in. line extending as far west as the Hollow Pool at Burrton.

Kaw Valley Pipe Line Company officers, elected at the time the organization was perfected, are as follows: B. E. Hull, The Texas Pipe Line Company, president; J. K. McGoldrick, The Texas Pipe Line Company, vice-president and general manager; F. K. Haskell, Empire Pipe Line Company, vice-president; E. F. Guidinger, Standish Pipe Line Company, vice-president; H. L. Stewart, Texas Pipe Line Company of Oklahoma, secretary-treasurer; and C. E. Murray, Empire Pipe Line Company, B. A. McKeren, Texas Pipe Line Company of Oklahoma, and F. L. Feist, Standish Pipe Line Company, assistant secretaries. The board of directors includes B. E. Hull, J. K. McGoldrick, and J. W. Stewart as representatives of The Texas Company; E. F. Guidinger, J. R. Harris, and E. V. Kile representing the Phillips Petroleum Company; and A. W. Ambrose, F. K. Haskell, and C. S. Warren of the Empire Oil and Refining Company.

The line will have a daily capacity of 20,000 bbls., and will open Western Kansas to greater oil development, as well as providing an outlet for many wells now without an outlet. The Texas and Empire companies, which own and operate a joint oil pipe line known as the Texas-Empire Pipe Line from Oklahoma to Chicago, will take delivery of crude at Valley Center where the Empire's 12-in. line has its western terminus.

●

H. C. Price, Inc., of Bartlesville, Oklahoma, announce they have been awarded the contract for electric welding approximately 18 miles of 6-in., 10-in., 12-in., and 16-in. line pipe for the Phillips Petroleum Company in Moore County, Texas. J. R. Stewart Construction Company of Oklahoma City are the general contractors. Construction on this job already has started.

●

The Valley Pipe Line Company's line from the Sam Fordyce field of Hidalgo County, Texas, to Port Isabel has been completed. The first crude was sent through the 5½-in. carrier October 8. Terminal facilities at Port Isabel also have been completed, but the refinery at that point is still under construction. Approximately 5000 bbl. of crude oil are being pumped through the line daily at present.

●

H. C. Price, Inc., Bartlesville, Oklahoma, have been awarded the contract for electric welding approximately 61 miles of 12-in. and 56 miles of 10-in. line in Wyoming and Nebraska for the North Central Gas Company. Williams Brothers, Inc., of Tulsa, Oklahoma, are the general contractors. Work on the line already is under way.

●

The Union Oil Company of California is laying an 18-mile, 12-in. oil line from the Bakersfield area to McKittrick where it will tie in with the company's trunk line to the coast. The existing 8-in. line has been handling approximately 25,000 bbl. of oil daily, and the new line will increase the movement to 40,000 bbl. or more.

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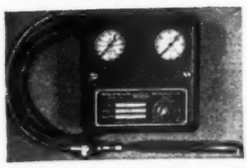

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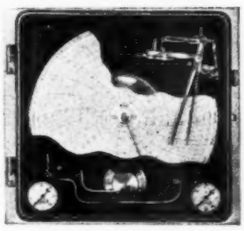

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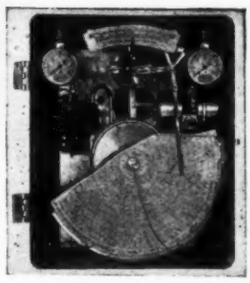

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3050 B Ind. 3000 B Rec.
Pressure Controllers
2050 B Ind. 2000 B Rec.

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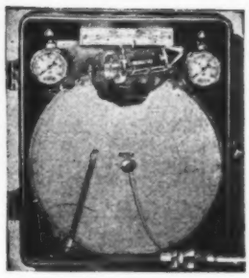

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LATEST ACTIVITIES IN THE OIL FIELDS

THE Oklahoma City field has been given an extension to the northwest by the British-American Oil Producing Company's No. 1 Mary Green, 1101 ft. from the executive mansion of Governor Marland. The Wilcox sand was topped at 6328 ft. and the hole drilled to a total depth of 6365 feet. After swabbing, the well started producing at a rate of 40 bbl. per hour, the flow increasing until at four p. m. of the first day it was 220 bbl. per hour. The oil tested 39.6 gravity.

●

Bee County, Texas, continues to be the scene of oil discoveries. A new Conroe sand pool that may prove extensive was found when George M. Church's No. 1 Woods, three and a half miles southeast of Beeville, was completed making approximately 100 bbl. of 62.9 gravity oil per day and much gas. The well was drilled to a total depth of 5831 feet.

●

Drilling activity in the Del Rey Hills extension of the Venice field, Los Angeles County, California, apparently is about over. During the last few weeks several tests have been abandoned or suspended, leaving but two active drilling operations in the area.

●

A new field has been found on the Louisiana Gulf Coast. The Texas Company's No. 16 Garden Island Bay, Plaquemine Parish, is producing from the Miocene formation after being drilled to a total depth of 4930 feet. The well, situated at the mouth of the Mississippi River, is the farthest producer south and east on the Louisiana Gulf Coast. On the initial test it flowed 525 bbl. per day through ¼-in. choke.

●

Duval County, Texas, was the scene recently of the discovery of two new oil pools. One was opened by the No. 2 Warden and Drought, joint well of the Sun and Simms oil companies. This well was drilled to a total depth of 1581 feet. The second strike was the Magnolia Petroleum Company's No. 2 Duval County Ranch, one and a half miles northwest of the main Government Wells field. This well was drilled to a depth of 1971 feet.

●

Increased drilling activity is expected in the Ogemaw County, Michigan, area as a result of the successful completion of Strange and Fortney's State B-1. The well was drilled to a depth of 1800 ft., and is producing from the prolific Traverse lime. Open flow production has been estimated at 12,000 bbl. daily based on tank gauges taken hourly.

●

Anderson-Kerr et al's No. 1 Wernet, six miles south of the town of Windown, opened a new pool for Rice County, Kansas. The well topped chat at a depth of 3287 ft., plugs were drilled to 3295 ft., and 300 ft. of oil was standing in the hole.

Sixteen miles northeast of Hays in Ellis County, Louis Roark et al's No. 1 Bemis had a good showing of oil at a total depth of 3050 feet. It is thought this discovery may prove of importance.

●

With the wildcat test of C. J. Davidson, Fort Worth, and the Honolulu Oil Corporation, Midland, Texas, on the L. P. Bennett Ranch in Yoakum County, West Texas, showing for a producer, extensive possibilities are seen for the area. Nearest production is 33 miles to the southwest. The well, drilled to 5090 ft., filled 75 ft. with oil the first hour after the tools had penetrated the producing horizon, and the following day increased to 800 feet.

●

The Standard Oil Company of Arabia has a good showing of oil in its first test in Eastern Saudi Arabia, 25 miles west of the recently-discovered Bahrein Island field. The test, known as the Dammam well, is eight miles from the coast, and was drilled to a total depth of 1900 feet. This discovery may prove of great commercial importance, in view of the nearness to the coast, the shallowness of the producing zone, and the quality of the oil, which contains no free sulphur in the gas.

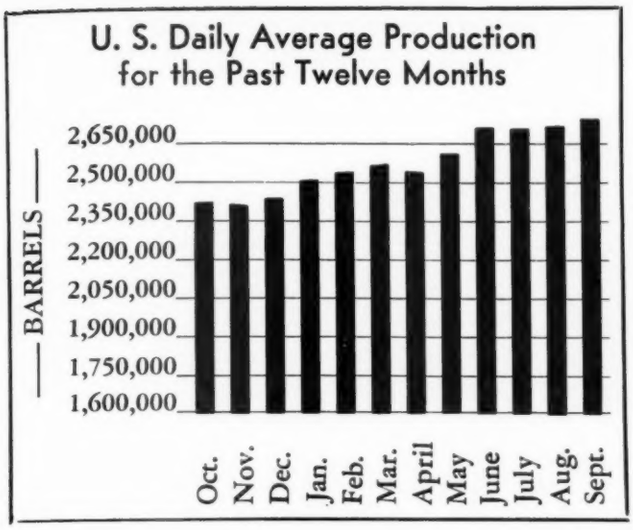
AVERAGE CRUDE PRICES

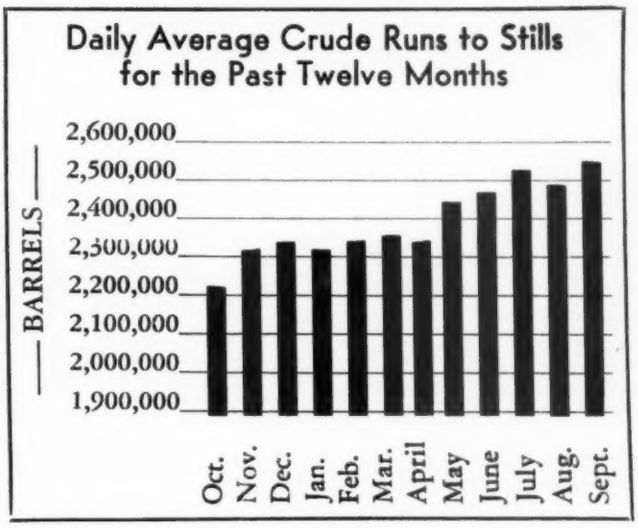
California		**Louisiana**	
Playa Del Rey	$ .48	North Louisiana	$ .95
Coalinga	.54	Gulf Coast	1.04
Signal Hill	.55	**Illinois**	1.13
Montana	1.35	**Kentucky**	1.13
Wyoming	1.00	**Indiana**	1.12
Colorado	1.00	**Ohio**	
New Mexico	.75	Lima	1.30
Texas		**Michigan**	1.02
North Central	.95	**Pennsylvania**	
Panhandle	.51-.71	Bradford	2.00
West Texas	.70-75	Southwest	1.72
Gulf Coast	1.04	Eureka	1.67
Darst Creek	.87	Buckeye	1.52
East Texas	1.00	Corning	1.32
Kansas	1.00	**West Virginia**	1.67
Oklahoma	1.00	**Canada**	2.10-2.17
Arkansas	.70		

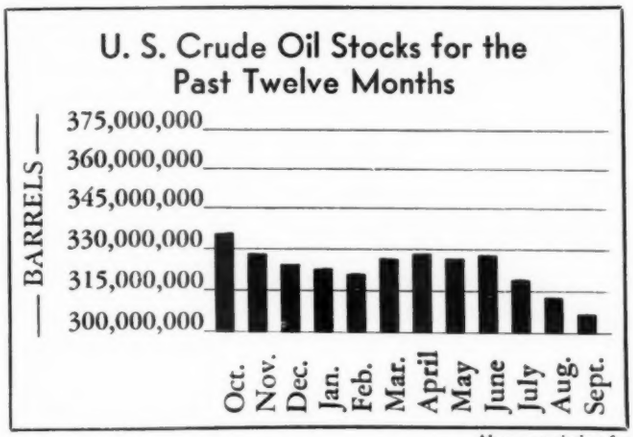
DAILY AVERAGE CRUDE PRODUCTION
Furnished by A. P. I.

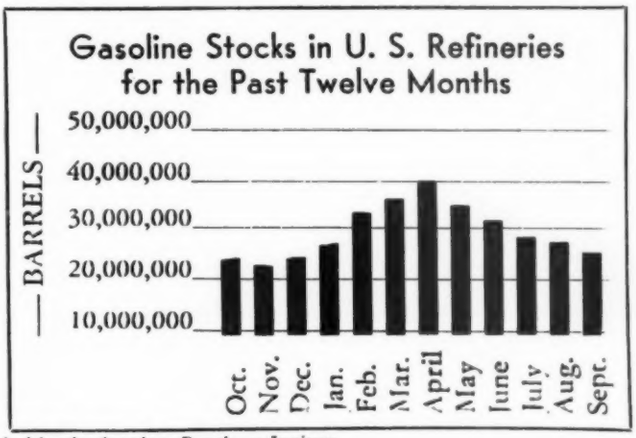
(Figures in Barrels)

	B. of M. Dept. of Interior Calculations (September)	Week Ended Sept. 28 1935	Week Ended Aug. 31 1935	Week Ended Sept. 29 1934
Oklahoma	506,000	492,150	471,700	451,200
Kansas	151,900	147,550	139,750	122,150
Panhandle Texas		55,550	51,950	61,600
North Texas		59,000	57,600	59,050
West Central Texas		25,600	25,800	27,850
West Texas		155,050	150,000	157,250
East Central Texas		47,200	47,850	52,150
East Texas		444,800	439,250	427,050
Southwest Texas		60,600	58,600	57,700
Coastal Texas		194,000	148,300	178,350
TOTAL TEXAS	1,059,900	1,041,800	1,018,700	1,021,000
North Louisiana		27,800	24,550	23,900
Coastal Louisiana		121,350	120,900	75,450
TOTAL LOUISIANA	126,300	149,150	145,450	99,350
Arkansas	29,200	30,250	30,300	31,250
Eastern	100,500	104,750	102,600	104,200
Michigan	38,000	52,500	48,050	33,500
Wyoming	35,600	37,750	38,050	38,950
Montana	10,600	13,050	13,200	11,500
Colorado	4,500	4,900	4,400	3,450
New Mexico	50,800	56,250	57,200	46,850
TOTAL EAST OF CALIF.	2,113,300	2,130,100	293,800	1,963,400
California	499,700	633,100	595,700	438,700
TOTAL UNITED STATES	2,613,000	2,763,200	2,665,100	2,402,100









Above statistics furnished by the American Petroleum Institute.

Summarized Operations in Active Fields for September, 1935

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	229	219	78	125	3600	2	40	Rotary
Duval County	44	36	2	6	2300	2	22	Rotary
Archer County	41	19	7	22	660–1800	1 or 2	40	Rot.-Cab.
Conroe	7	6	1	4	2000–7400	3 or 4	40	Rotary
Panhandle	57	48	31	124	2200–3900	2	40	Rotary
Refugio County	9	7	1	3	5200	2	38	Rotary
OKLAHOMA								
Oklahoma City	8	7	6	49	6500	3	39	Rotary
Pontotoc County	24	17	3	58	1800–4488	2 or 3	38	Rotary
Osage County	26	21	9	44	380–2850	2	37.5–40	Rot.-Cab.
KANSAS								
McPherson County	8	6	2	15	2900–4300	2	38	Rot.-Cab.
Harvey County	4	3	2	6	3450	2 or 4	37	Rot.-Cab.
Ellsworth Arch	54	35	15	96	3300	4	37	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	4	4	6	23	8300	3 or 4	40	Rotary
Long Beach	9	9	31	55	7000	3	36	Rotary

Field Activities by States for September, 1935

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1934 (In Barrels)
	September	August	September	August	September	August	September	August	September	August	
Arkansas	6	7	2	2	11	9	9	11	33	30	11,412,100
California	65	82	61	75	68	90	110	82	258	278	175,678,362
Colorado	....	2	....	1	....	....	2	5	32	23	1,168,000
Illinois	....	....	....	....	....	....	14	16	9	10	4,466,000
Indiana	21	29	5	16	....	....	2	2	33	38	813,000
Kansas	115	109	78	82	105	135	30	39	199	244	45,577,050
Kentucky	18	19	16	14	....	....	8	3	11	19	4,963,000
Louisiana	60	62	34	36	61	67	35	70	139	152	32,572,900
Michigan	63	60	44	39	65	55	129	98	251	158	10,589,600
Mississippi	2	1	0	0	....	....	2	2	11	10	Gas Prod.
Montana	18	21	16	17	....	....	11	12	54	60	3,797,000
New Mexico	27	21	27	19	....	....	13	23	104	97	16,529,050
New York	....	....	....	....	....	....	0	1	3	5	3,880,700
Ohio	123	108	82	84	....	....	34	30	129	74	4,291,000
Oklahoma	192	173	126	122	189	180	51	79	504	513	176,506,550
Pennsylvania	12	6	10	4	....	....	29	36	115	117	15,353,850
Texas	846	1085	631	810	1035	1015	381	295	1192	1103	380,848,000
West Virginia	32	35	25	28	....	....	24	28	91	76	4,043,550
Wyoming	7	10	5	9	....	....	10	12	72	78	12,371,100
Total	1627	1330	1162	1358	1534	1551	894	844	3240	3085	903,350,812

THE MONTH'S ACTIVITIES IN REFINING

Per Cent Refinery Capacity Operated

Eastern Division, 81.6 percent **Central Division, 70.2 percent** **Western Division, 71.6 percent**

THE Lone Star Gas Company, Dallas, Texas, plans to construct a high-pressure gasoline absorption plant of 100,000,000 cu. ft. daily capacity in the vicinity of Trinidad, Texas, on the route of the new 109-mile Long Lake-Cayuga-Irving pipe line, it has been announced. The construction work will be done by the Lone Star's own men under the supervision of J. L. Foster, chief engineer, and J. R. Jarvis, superintendent of gasoline plants. It is planned to have the plant in operation by the first of the year.

●

Work has started on a refinery, capacity 2500 to 3000 bbl., at Alma, Michigan, by the Acme Refinery Corporation. E. G. Guy, Mount Pleasant, refinery engineer, is supervising the construction.

●

A new refinery, the Bright Star Company, has started operating at El Dorado, Arkansas, on the site of the old Kettle Creek refinery. The plant is manufacturing lubrication distillate, processing 1000 bbl. daily. The distillate is being sent to the refinery of the MacMillan Company at Norphlet, near El Dorado, and there made into lubricating oils.

●

A 500-bbl. skimming plant has been constructed near Olney, Texas, by the Anarene Oil and Refining Company. The company is headed by Ralph McQuigg. C. H. Petty is superintendent.

●

A $50,000 expansion program is under way at the Shoreline Oil and Gas Company's refinery at Lewis, Caddo Parish, Louisiana. A new canning unit is being added and some of the old equipment replaced.

●

The Waggoner Refining Company has moved its offices from Electra to Vernon, Texas.

●

The Gregg-Tex Gasoline Corporation is doubling the capacity of its plant near Longview, Texas. The present equipment will be duplicated and when installed 14,000,000 cu. ft. of gas will be processed per 24-hour day, producing approximately 50,000 gal. of gasoline. A 20-in. main gathering line, and laterals, will connect with 650 additional wells. Petroleum Enginering, Inc., associated with Arthur G. McKee and Company, furnished the design and equipment.

●

The Pan American Refining Corporation has awarded a contract to the Foster Wheeler Corporation for the construction of a Universal catalytic polymerization unit at its Texas City, Texas, refinery. Approximately 2000 bbl. of Polymer gasoline will be produced daily.

●

Plans of the Curacaosche Petroleum Industrie Maatschappij for renewing a part of the equipment of its plant are making rapid progress, according to a report from Consul Russel M. Brooks, Curacao, Netherland West Indies. Under the supervision of an American engineer the new reforming unit is being installed. Bases for new storage tanks, of which 25 are to be added, are taking shape, while two cracking units are almost completed.

The Curacaosche Petroleum Industrie Maatschappij recently added two shallow draft oil tankers suitable for the Gulf of Maracaibo trade that are to be added to its fleet of 32 tankers employed in bringing oil from Venezuela to Curacao. The new tankers are said to have a capacity of 500 tons more than ships now operated. Houses are being erected to care for the refinery personnel.

The Arend Petroleum Maatschappij in Aruba has almost erected its reforming unit and will be ready to top gasoline within a short time. A year ago this plant was reported as ready to close down definitely, but because of troubles of its parent company (Mexican Eagle) in Mexico, apparently it has been decided to enlarge the facilities of the Aruba refinery.

●

In order to provide cheap petroleum products for domestic consumption, the Government of Iraq has decided to build an oil refinery, for which it has an option. Hitherto, petroleum products have had to be brought from Abadan, Iran (Persia) or from Khanaqin, on the border between Iraq and Iran. This has resulted in high prices for petroleum products.

Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks, Week Ending September 28, 1935

A. P. I. Figures

(Figures in Barrels of 42 Gallons Each)

DISTRICT	Per Cent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Per Cent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	501,000	81.9	13,583	13,419
Appalachian	94.8	115,000	78.8	1,820	910
Ind., Ill., Ky.	95.9	357,000	84.2	7,519	4,794
Okla., Kans., Mo.	84.8	277,000	72.1	4,039	4,888
Inland Texas	48.5	91,000	56.9	1,034	1,575
Texas Gulf	96.4	558,000	93.8	4,804	11,674
La. Gulf	96.4	121,000	74.2	992	4,560
No. La.,-Ark.	90.0	39,000	54.2	285	459
Rocky Mountain	61.9	47,000	78.3	513	780
California	92.6	512,000	64.9	8,387	65,576
TOTALS WEEK:					
Sept. 28, 1935	89.5	2,618,000	76.9	42,976	108,635
Sept. 21, 1935	89.5	2,643,000	77.6	42,572	107,082

Handling Small Production By Gas Lift...Oklahoma City Field

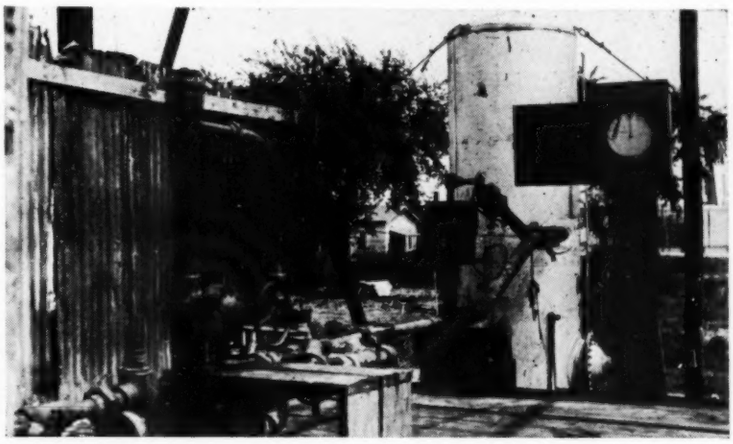
Part I

By
S. F. SHAW
Consulting Engineer,
San Antonio

THE price of oil has been comparatively low during practically the entire period that the Oklahoma City field has been producing, consequently serious effort has been made to lift the oil at the minimum cost; however, a large part of the ultimate recovery in this field will have been obtained under natural flow conditions, hence the high costs attending the lifting of oil at great depths did not apply to early operations in this field.

When wells in the Oklahoma City field ceased to flow naturally, and were placed on gas-lift — and this was the history of about 90 percent of all the wells in this field — it became necessary to consider the expense of operations.

In most cases the immediate outlay of capital by the small operators for installing compressor equipment was avoided, especially in the early gas-lift stage of the Oklahoma City wells, since gas was furnished by three or four of the large operators at a charge ranging from six cents to eight cents per thousand cu. ft. (2-lb. pressure base). This carried the small operator over a troublesome period of capital investment but eventually brought about difficulties in the latter stage of production, in that the cost of the gas at this price became prohibitive when wells had declined to a daily production of 100 to 200 barrels. Even in the case of the large operator it became necessary to economize in the consumption of gas, in order to avoid large additions to compressor plants that could not be used in their entirety for more than a comparatively short period, owing to the very rapid decrease in oil production after the decline once set in.



Westgate Oil Company No. 1 Blevins, Oklahoma City field, produced by intermittent gas-lift at rate of 5 bbl. of oil per day through 2½-in. tubing

The gas-lift methods that have been employed for handling wells in the Oklahoma City field after they have reached the stage of small producers, are as follows:

1. Natural flow.
2. Continuous or "straight" gas-lift.
3. Intermittent flow through casing.
4. Intermittent flow through casing with packer and chamber.
5. Intermittent flow through tubing with plunger lift.

Natural Flow

There are several wells flowing naturally even at this late date in the Oklahoma City field. Many of these wells are small, ranging from 50 to 300 bbl. per day. There are also some wells flowing naturally that are considerably larger than 300 bbl. per day. The small wells are often in the class that cannot make a potential sufficiently large to raise their allowable above the marginal class, therefore, they are allowed to produce at the rate of 150 bbl. per day if, indeed, they are able to make that amount. This is the least expensive method that can be employed. Natural flow obviates, or delays, the comparatively high capital outlay necessary in this field to equip a well for artificial lifting; however, natural flow at low bottom-hole pressure must be at the expense of high gas-oil ratios.

Gas-oil ratios may run as high as 10,000 cu. ft. per bbl. in wells flowing naturally at the rate of 100 bbl. per day in areas where the reservoir pressure has declined to something under 200 lb. per sq. in. and where the bottom-hole flowing pressure is between 50 and 150 pounds. An interesting instance of a test on a well flowing naturally at the rate of 65 bbl. per day showed a gas-oil ratio of 24,650 cu. ft. per barrel. When the paraffin was cleaned out of this well the production of oil increased on natural flow to 1062 bbl. per day, and the gas increased to 4,850,000 cu. ft. per day. The gas-oil ratio was reduced to 4570 cu. ft. per bbl. by reason of producing the oil at this increased rate.

Continuous Gas-Lift

A few gas-lift wells, making as little as 100 bbl. per day, are still being produced on continuous gas-lift, although it is seldom that such a well can be produced profitably by this method if it is necessary to purchase compressed gas for this purpose. With input factor amounting to between 5000 and 10,000 cu. ft. per bbl. the entire revenue obtained from a well making 100 bbl. per day on continuous gas-lift is absorbed by the cost of the compressed gas purchased at eight cents per thousand cu. feet.

A few operators built small compressor plants in the early gas-lift stage of the wells and have paid out the cost of the installation on basis of eight cents per thousand cu. ft.; therefore, at the present time the cost of compressing the gas may be as low as two cents to three cents per thousand cu. ft., at which cost a well making as little as 100 bbl. of clean oil per day on continuous flow can show a fair margin of profit.

TABLE 1

Quantity of Output Gas Required to Lift One Barrel of Oklahoma City Oil on Continuous Flow at Maximum Capacity at a Given Bottom-Hole Flowing Pressure

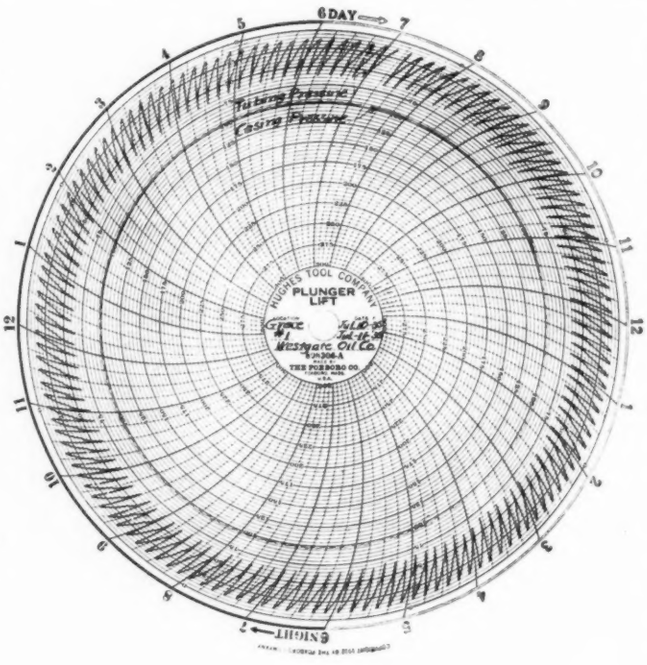
Lb. Bottom-Hole Flowing Pressure	*Cu. Ft. per Bbl. of Oil Lifted*
500	1,000
400	1,350
300	2,000
200	3,100
100	6,400

Installations of small plants equipped with small gas-engine-driven compressors paid for themselves in from six to ten months on basis of eight cents per thousand cu. ft. when handling fairly large production. One plant consisting of five large-type compressors with aggregate capacity of 5,000,000 cu. ft. per day paid for itself in about eight months of operation, based on price of eight cents per thousand cu. feet. Another plant containing ten 90-hp. compressors paid for itself in less than six months. Other plants have shown equal or better pay-out basis, and are now operating "on velvet" and still possess a fairly high salvage value.

The quantity of output gas required to lift one bbl. of clean oil on continuous flow, at maximum capacity, and at different bottom-hole pressures is approximately that given in Table 1. The quantity of gas noted in this table is the required quantity of output gas. The input gas is another factor, and will depend on the formation gas-oil ratio. In wells a few locations below the crest of the Wilcox sand, the gas-oil ratio is roughly 250 to 1000 cu. ft. per barrel. If, for example, the gas-oil ratio is 700 cu. ft. per bbl., and the bottom-hole flowing pressure is 300 lb., the input gas required is 2000 cu. ft. (Table 1) less 700 cu. ft., or 1300 cu. ft. per barrel.

The production of small wells on natural flow, or on continuous flow, especially if the compressed gas reaches the well at a low temperature, causes a deposit of paraffin to form on the casing and on the tubing in a surprisingly short time, and eventually restricts the area of the flow pipe to the point where only 10 to 50 percent of the normal capacity of the pipe is available.

The deposit of paraffin is thickest close to the top of the well, and gradually tapers off until a point is reached at about 2000 ft. below the casing-head, where little paraffin forms. There is less trouble on the score of paraffin if the compressor plant is situated close to the well and the input gas reaches the well at a fairly high temperature, that is, 125 to 150 deg. fahrenheit.



Casing and tubing pressures of a well intermitting naturally through 3-in. tubing, Oklahoma City field.

Intermittent Flow

After wells in the Oklahoma City field operating on continuous gas-lift have declined to some point between 200 and 300 bbl. per day, it has been observed that the production can be increased to 500 bbl. or more by placing them on intermittent flow. This transition takes place when the flowing pressure is between 100 and 200 pounds. Not only can the production be increased, but the consumption of input gas is reduced by 25 to 50 percent of that required on continuous flow.

Among early wells placed on intermittent flow without packer was the Slick Estate No. 1 Miller, which was flowed five times per day with gas admission of 15 min.; also same company's No. 1 Milner, which was flowed once each hour with 15-min. gas admission. Both of these wells are in the Simpson zone and produced from 50 to 200 bbl. of oil per day. An intermitter, built by L. L. Shipman of the T. B. Slick Company for controlling the period of gas admission by means of a clock, operated with a good degree of satisfaction.

Another well in the Wilcox zone, operated in this manner for a time, was that of the Kessler Oil and Gas Company No. 1 Grace. W. L. Clark, superintendent of the Kessler Oil and Gas Company, believed that the injection of gas into this well was driving some of the oil back into the sand after the pressure had declined to a low point, and to remedy this objection, developed a packer and chamber device, termed a "bottom-hole intermitter," which has since been extensively employed in the Oklahoma City field. About 135 wells in this field have been equipped with this flow device.

The bottom-hole intermitter has been employed in casings of $5\frac{3}{16}$ in., $6\frac{5}{8}$ in., 7 in., 9 in., and $9\frac{5}{8}$ in. O.D.

A well in the north section of the Oklahoma City field was completed with $6\frac{5}{8}$-in. casing and had produced on natural flow until July, 1935. After natural flow ceased, the well was placed on intermittent flow, using a "bottom-hole intermitter." The cycle consists of five min. on and seven min. off, making five complete cycles per hour. Production is 700 bbl. per day. The pressure at the well ranges from 650 lb. at the high point of gas-admission pressure to 115 lb. after the gas has been closed off and the flow has subsided. The input gas-factor is approximately 2500 cu. ft. per barrel.

A compressor plant was built to handle this well, together with other wells, and is connected to two wells on intermittent flow, also to a half-mile length of 6-in. pipe, which is used as a storage reservoir to receive the gas from the plant during the time that gas is not being injected into the wells.

Some trouble was experienced in operating these two wells with intermittent top-hole intermitters actuated by clocks, in that there was a tendency for the clocks to get

"into step" with each other, thus drawing gas to both wells simultaneously, also closing off the gas admission at the same time. This was remedied by placing one intermitter close to the plant and providing a single clockwork with two wheels such that two diaphragm valves could be controlled by the same clock, thus maintaining the timing of the cycles of the two wells with proper relation to each other.

TABLE 2

Production of Oil and Consumption of Input Gas in No. 1 Vaughan

Month	Bbl. per Month	Cu. Ft. Input Gas per Bbl.
March, 1935	16,851	1,530
May	20,210	2,193
June	18,927	2,610
July	13,851	3,159

The Mid-Texas Petroleum Company No. 1 Vaughan was completed with 7-in. casing, and was equipped with bottom-hole intermitter in October, 1934. The production of this well is shown in Table 2.

Gas for No. 1 Vaughan was purchased at eight cents per thousand cu. feet. In July, 1935, a compressor plant, consisting of three 90-hp. gas-engine compressors, was installed and furnished part of the input gas required. This gas is pumped into the high-pressure line of the company that sells gas to the Mid-Texas Company, and the input gas is injected to the wells from the high-pressure line to prevent a high pressure from building up during intermissions.

Another well was completed with 9-in. casing and was later equipped with bottom-hole intermitter with results shown in Table 3. The input gas was purchased from a high-pressure line at eight cents per thousand cu. feet.

TABLE 3

Production of Oil and Consumption of Input Gas in a Well With 9-in. Casing

Month	Barrels Produced	Cu. Ft. Input Gas per Bbl. Oil
December, 1934	6,697	812
January, 1935	8,363	668
February	7,547	761
March	8,467	848
April	6,121	838
May	6,217	815
June	2,266	1,550

The quantity of input gas required for intermitting in the Oklahoma City field depends largely upon the conditions prevailing. In a well with large potential but with comparatively small allowable, the cycle per flow may be as long as 1½ hours. In this case, a greater length of time is allowed for the accumulation of oil in the casing, or chamber, and the quantity of oil lifted per flow is considerably greater than when a short cycle is employed. This results in a smaller quantity of input gas being required per bbl. lifted. This point is illustrated by the data in Table 4, resulting from tests made on the well with 9-in. casing mentioned in the preceding paragraph. The potential of this well was 915 bbl. per day.

It will be noted in Table 4 that as the actual production approached the potential capacity, the quantity of input gas per bbl. gradually increased.

TABLE 4

Quantity of Gas Per Bbl. Required for Lifting on Intermittent Flow at Different Intervals on a Well in the Oklahoma City Field

Min. per Cycle	Bbl. per Cycle	Bbl. per Day	Lb. Pressure Input Gas	Cu. Ft. per Cycle	Cu. Ft. Input Gas per Cycle
75	16.5	317	240	125,000	758
60	16.7	408	215	132,000	790
30	10.8	518	210	119,500	1,104

The cycle employed in the Oklahoma City field for intermitting through the casing varies between rather wide limits. As noted in Table 4, when the allowable is low with respect to the potential, the cycles can be rather far apart. The time of actual gas admission varies from four to eight minutes, but this period depends upon the diameter of the casing and of the tubing. In wells with 9-in. casing and 3-in. tubing, the duration of gas admission is from four to six min. with input pressure of 200 to 250 lb., after reservoir pressures have declined to about 200 lb. per sq. inch. With similar reservoir pressure, when employing 6⅝-in. casing with 2-in. tubing, the pressure required for best results is from 500 to 700 lb., and the duration of the gas admission is from five to six minutes.

Pressures required for successful intermitting through the casing in the Oklahoma City field are about 500 lb. per sq. in., taking into consideration average conditions of wells with various sizes of casing. In wells with small casing and small tubing, high pressures are desirable to get the maximum production. It is possible to use lower pressures in wells completed with 9-in. casing or larger, provided 3-in. or 4-in. tubing is employed.

In employing high pressures, and in using long pipe lines on the surface, there is a cooling effect between the compressor plant and the well, also there is a considerable drop in pressure in the well when the gas is injected through a small tubing into the well. This effect of radiation and expansion tends to chill the gas, and accelerates the tendency for paraffin to deposit on the walls of the casing and tubing, and in the course of time makes it necessary to pull the tubing and scrape off the paraffin. It is highly desirable not to allow this deposition to accumulate to an excessive thickness, otherwise it is troublesome to remove the packer and in extreme cases the tubing might be pulled apart.

In one instance where the purchase of high-pressure gas became too burdensome for operating two wells on intermittent flow, a small plant was installed, consisting of four 90-hp. direct-driven gas-engine compressors, with capacity of approximately 1,500,000 cu. ft. per day, or 1,300,000 cu. ft. per day on a 2-lb. pressure base, thus reducing the charge for input gas by about $3100 per month. This plant was installed at a cost that can be paid out in about six to seven months. In the course of time, after these two wells have declined considerably, it may be desirable to install the tubing-type of intermitter, or a pneumatic head, in which case each of these two small compressors will be capable of handling one well, and the cost of plant operation will then be considerably reduced.

Editor's Note—Part 2, concluding this article, will appear next month.

Construction Methods Employed on 109-Mile Gas Line

By

FRANK H. LOVE

Extreme care exercised in cleaning, coating, and wrapping the pipe—Large diameter of pipe (20-in.) necessitated making all bends by hot method

WITH work progressing in a satisfactory manner on the Lone Star Gas Company's 109-mile 20-in. line from the Long Lake and Cayuga fields of Anderson County, Texas, to Irving, near Dallas, its completion early in the fall, in sufficient time to deliver gas to the system for meeting increased cold weather consumption, is now assured. The line, except for a few miles of new pipe, is being constructed of reconditioned stock salvaged from a line laid in 1929 between Birdville, Texas, near Fort Worth, and Petrolia. Methods employed in reconditioning the pipe have been discussed in a previous article in *The Petroleum Engineer*.[1]

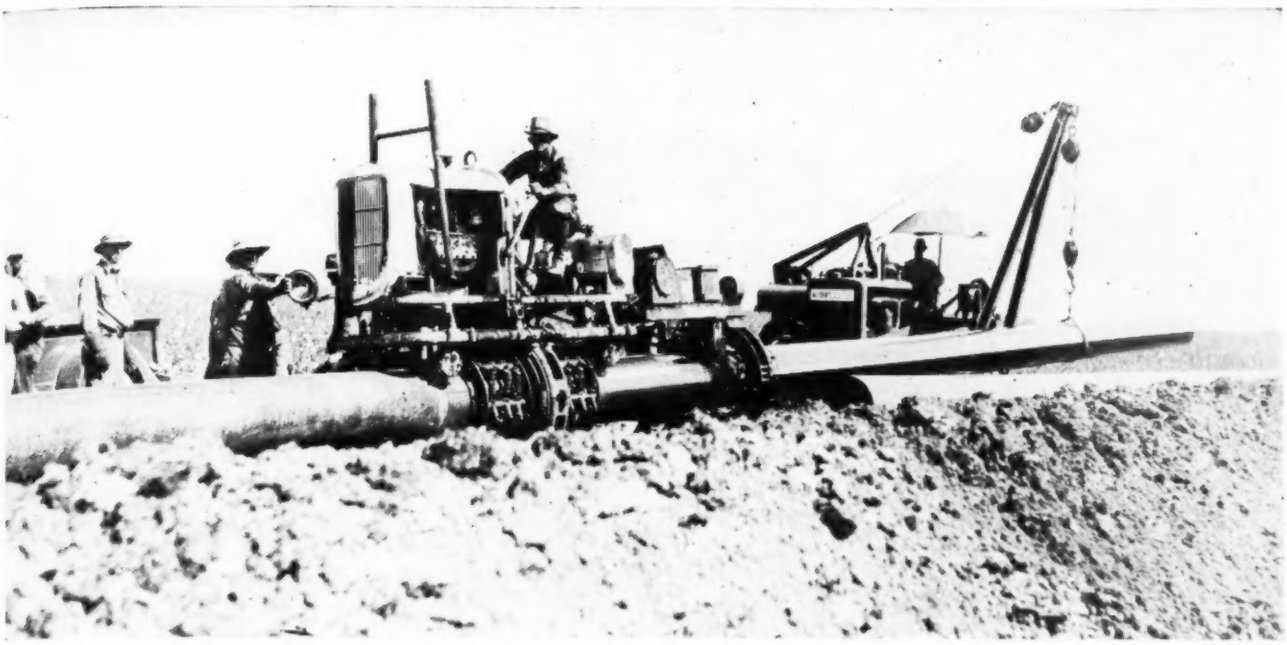
The line from Long Lake and Cayuga to Irving is being laid by the Oklahoma Contracting Company, of Dallas, and Ford, Bacon & Davis of Dallas and New York. The former is in charge of the work on 67 miles of the line from Irving to a point between Kerens and Trinidad, while the latter has the 42 miles from that point to the Cayuga and Long Lake fields. The Day Construction Company of Dallas is electric welding the entire line.

As an initial step in construction of the line, the reconditioned pipe was shipped as needed to convenient points along the route, to Kerens, Alsdorf, Crisp, Trumbull, Ferris, Lancaster, Duncanville, Irving, Trinidad, Malikoff, Palestine, and Tucker. From flat cars it was loaded onto one-and-a-half and two-ton trucks, three 60-ft. lengths of pipe comprising a load, and transported to the right-of-day. Unloading from the flat cars was accomplished by use of trucks, usually of five tons, equipped with a specially-constructed rear-end boom crane. In the field a truck with a side boom and winch was used for unloading. No unusual difficulties were encountered in stringing, although in some of the bottom land following rains there were times when the pipe had to be pulled in by teams or the trucks assisted with tractors.

A trench 32 to 36 in. in width and 40 to 48 in. deep is being cut. The depth of the ditch shows considerable variance, depending upon the contour of the country and unusual right-of-way conditions and requirements, in some instances being as

[1] "Speed Characterizes Reconditioning of Large Diameter Gas Line," *The Petroleum Engineer*, August, 1935.

Crossing the Trinity River near Trinidad, Texas



The cleaning machines each averaged approximately a mile a day

much as eight feet. General practice is to provide a 20-in. covering for the pipe, although this also is altered by conditions. Where the line traverses low land, at certain seasons of the year under water, a 30-in. covering is provided in order to eliminate the possibility of the pipe floating out of the ditch. In addition to the extremely low land, mostly on the south 42 miles of the line, there also is considerable timber in that section. For the most part, however, ditching has presented minor difficulties on that end of the line. The north section also proved easy going until the ditchers reached a point a few miles south of Lancaster, where they began to encounter rock, and from there to the end of the line at Irving blasting will have to be resorted to intermittently. The last three miles of that portion of the line is bottom land that may present some difficulties, and as the line nears completion it will be necessary to make a crossing of the Trinity River. The ditchers employed are the large-model machines and, with two on either end of the line, the four have been totaling approximately 15,000 to 16,000 ft. per day.

The pipe is being welded into 120-ft. lengths with each section joined by a Dresser coupling. Despite the large diameter of the pipe the firing line welders have made some exceptionally good speeds, each averaging approximately 25 welds per day. Six welding machines are employed by each gang (there being one firing line crew on either end of the line), five for making roll welds and one for tacking. In addition two machines are in constant use for making repairs, setting gate valves, etc., and several are held in reserve for emergency purposes.

The entire line is being coated with hot enamel and wrapped with asbestos felt. Prior to this operation, however, the pipe is cleaned and the primer applied with a W-K-M traveling-type machine. A model recently designed for cleaning large-diameter pipe is used for the work. Equipped with 480 cutters and 12 brushes, each machine is capable of 16 ft. per minute in high gear. On this particular job an average of approximately one mile of pipe a day is being cleaned. Couplings are placed every 120 ft., and it is necessary that the pipe be left in that length sections until after it is cleaned, coated, and wrapped. Since the speed of cleaning would be greatly retarded were it necessary to clean a 120-ft. section, remove the machine from the pipe and remount it, this difficulty has been surmounted by the devising of a sleeve to fit over the joints, holding the sections of pipe together temporarily. The sleeve is placed in position ahead of the cleaning machine, and after the latter has passed, the rear section of pipe is disconnected and placed on skids alongside the ditch to await the "doping" gang. In this manner the cleaning machines are enabled to perform their work uninterruptedly and in the same fashion as if the line were a solid welded one.

Turning of the pipe for application of hot enamel and wrapping has presented a problem that has been overcome by the contractors devising special equipment to meet the need. The conventional method of turning the pipe by revolving the rollers on the dollies is impossible because of the uneven surface of the pipe, due to its not being entirely straight. It is necessary to apply the turning force to the pipe itself. Each of the contractors has devised apparatus that, while identical in principle, varies somewhat in minor details. One contractor has constructed a rectangular framework, 3 ft. by 4 ft., of 4-in. channel iron, with an adjustable leg made of 1½-in. pipe at each corner. To the exterior of this frame is attached an arrangement consisting of four shoes covered with brake lining. The shoes are in circular fashion and fit inside the end of the pipe to be turned. An arm extends from this to a hand wheel that, when adjusted, causes internal expansion of the shoes, forcing them to grip tightly the inside of the pipe. Connected with the shoe arrangement is a shaft driven by a power take-off mounted on the transmission of a truck, and in this manner the pipe is turned. The turning equipment used by the other contractor also has the shoe arrangement that fits inside the pipe, and the internal expander, the principal difference in the equipment being in the manner of furnishing power, supplied by an air motor and air compressor.

As the pipe is turned the hot enamel is poured over the topside. Some of the cans have spreaders made of galvanized iron attached to the spout that serve to distribute the enamel evenly. Immediately following the application of the coating holiday detectors are passed over the pipe and all defects marked and "doped." This procedure is repeated until no holidays are found.

Apparatus devised for turning pipe in coating and wrapping operations

The asbestos felt paper is spirally wrapped on the pipe by use of a saddle-type machine. In this instance the pipe is turned with the same equipment as that employed in connection with the coating. After being coated and wrapped the sections are coupled into the line and left on skids above the ditch to be lowered in. Lowering horses, constructed of 3-in. pipe and equipped with a hand-operated winch, are used on the south end of the line. Five of these, spaced approximately 40 ft. apart, comprise the required equipment for the work, four holding the pipe at all times while one is moving forward. Tractors are employed for lowering in on the north end of the line, consisting of a Caterpillar 60 and two 20's.

Coating, wrapping, tie-in, lowering-in, and back-filling crews work in a comparatively close spread. All couplings are being left uncovered in the ditch. The purpose in this is threefold: to permit bonding of the pipe, so that later on cathodic protection may be provided if needed; to aid in locating possible leaks when the line is tested; and in order that a special covering for the couplings can be installed after the line is completely laid. This latter procedure is of interest in that it is said to be the first line upon which the experiment is being tried. A wooden shield treated with a preservative to protect it against decay will be placed around each coupling. This is a box-appearing affair, into which is poured a special compound, completely filling the space between the outside of the coupling and the inside of the shield. The compound does not completely harden, but remains more or less resilient, allowing the coupling a certain amount of movement without cracking the former.

The large diameter of the pipe necessitates the making of all bends and sags by the "hot" method. Equipment used for this work consists of a kerosene torch, air compressor, bending block, a 30-ft. length of pipe, a fire shield, and winch. With the end of the pipe to be bent and the 30-ft. length fastened together securely by a cable, the bending block, hand winch, and fire shield in place, heat is applied to the pipe where the bend is to be made (not at the bending block), the torch being inserted between the shield and the outside of the pipe. No heat whatever is applied inside the pipe. When the application of heat has caused the pipe to become a cherry red a steady pull is given by means of the hand winch until the pipe is bent to the desired angle. Obviously it is impossible to turn the sections containing bends in the usual manner for cleaning and coating, and here the procedure is to clean and prime the pipe by hand, with the enamel coating "ragged on."

The route of the line crosses the Trinity River at two points, near Irving, which crossing has not been made as this is written, and a short distance west of Trinidad. The latter, while not a wide crossing, presented certain difficulties due to one bank of the river being extremely high. A pipe string 280 ft. in length was required. An 800-lb. river sleeve was placed every 30 ft., a total of seven being used. Between each of these was a lead-filled sleeve, eight being required, weighing 1500 lb. each. With the pipe string made up and the clamps in place, except that the sleeves had not been filled with lead, it was suspended above the river, a drag line boom supporting it on one bank and a tractor on the other. With the string in this position the sleeves were filled with lead and a NO-OX-ID coating applied to the pipe, crews working from rafts. The river trench was dug with the aid of a drag line and tractor. A minimum of three ft. of covering below the river's bed was provided.

As each 120-ft. section is welded, 50-lb. air pressure is applied and a soapsuds test made. When the line has reached a point where gas is available a test with 450 lb. pressure will be made between each gate valve, placed every eight miles, and again when the line is completed.

All bends were made by the "hot" method

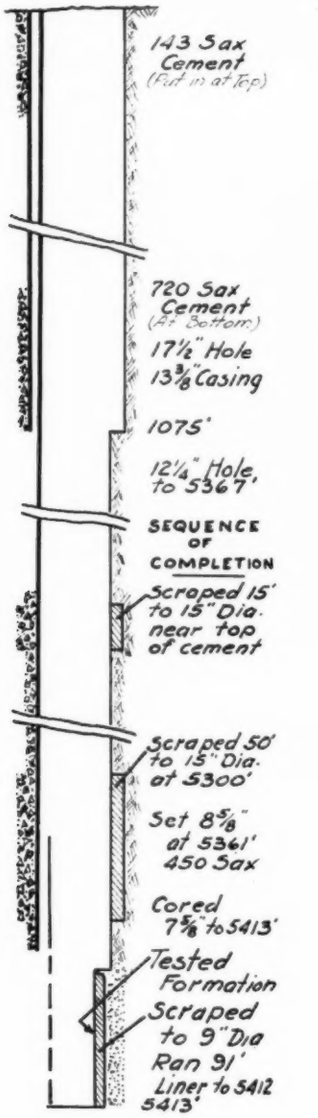

143 Sax Cement (Put in at Top)
720 Sax Cement (At Bottom)
17½" Hole
13⅜" Casing
1075'
12¼" Hole, to 5367'
SEQUENCE OF COMPLETION
Scraped 15' to 15" Dia. near top of cement
Scraped 50' to 15" Dia. at 5300'
Set 8⅝" at 5341' 450 Sax
Cored 7⅝" to 5413'
Tested Formation
Scraped to 9" Dia
Ran 91' Liner to 5412
5413'

Fig. 1

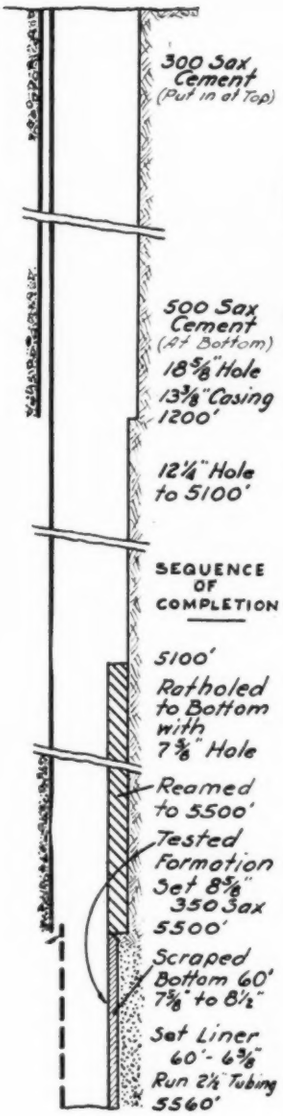


Fig. 2

Showing sequence of completion by scraping of two wells in the Edison field, California

Completing Wells with Rotary in Low-Pressure Fields

Scraping the face of the sand provides effective means of removing mud sheath

By

WALLACE A. SAWDON

Petroleum Engineer, Los Angeles

THE completion of wells with rotary tools has many advantages that have made it a practice more generally followed during the past few years. The method to be used for bringing the well in after it has been drilled to its total depth by rotary, however, requires careful consideration. This is especially true where the gas pressure in the producing zone is low and, consequently, can offer no assistance in removing the mud plaster from the sand face. Such a condition has been encountered in the Fruitvale, Weed Patch, and Edison fields around Bakersfield, California, and has been overcome successfully by scraping the face of the sand through its entire thickness before running the liner.

The primary objects of scraping in this particular area are to bring the wells in more easily and with greater speed; to make sure that the mud is completely removed from the face of the sand; and to provide hole below the casing into which the liner can be run without difficulty. The procedure, however, has resulted in getting bigger initial production than was at first expected or considered possible. This backs up the contention of many engineers that the full potential of a well cannot be obtained unless all the mud plaster caused by rotary drilling is completely removed from the wall of the hole; but it also indicates that this mud plaster can be taken off entirely and that its obstruction to the flow of the oil into the hole can be removed effectively.

It must be remembered that a mud sheath on the wall of the hole has distinct advantages that are probably more important when drilling through a low-pressure sand of high porosity than when completion is being made in a tight high-pressure sand. One of the greatest of these advantages is the protection offered by the mud plaster, which, by keeping water out of the sand, frequently insures a bigger initial production and a greater ultimate yield.

Water will penetrate to a considerable extent into the sand and, if not kept out, will often damage the area around the hole. The amount of water that will go into a sand naturally varies with the character of the formation, the porosity, and the pressure. In drilling with rotary tools in a low-pressure sand, the pressures applied by the pumps will often exceed the gas pressure in the sand and it is natural, therefore, that water will continue to enter the sand during drilling.

The solids in drilling mud will penetrate only to a negligible extent into even a very porous sand. Moreover, after a mud sheath has formed on the face of the sand, water cannot pass through it and into the formation. A mud that will seal quickly is, therefore, desirable. A drilling fluid with high colloidal content will usually provide this feature and will also form a mud sheath that is impermeable to water and yet be of minimum thickness. Fortunately, the Mojave mud being used in the Bakersfield district plasters the walls quickly and thoroughly.

It is certainly easier to scrape mud from the face of the sand than it is to extract water from the formation. While little or no mud leaves the hole, and the solids during the first circulation are filtered out to form a protective coating, the mud sheath is probably more deeply imbedded in loose

formations of low-pressure than it would be under different conditions. By scraping, however, the face of the sand can be removed to any practical extent desired and a virgin surface provided that will not only be totally free of mud but will also offer the least possible resistance to the flow of oil into the hole. It is probably the combined action of thoroughly removing the mud and cutting to a diameter greater than the original hole, thus exposing a totally virgin face as the wall of the hole, that has led to easy and quick completion of larger wells in the Fruitvale, Weed Patch, and Edison fields.

Removal of Mud Plaster Necessary

As mentioned above, the Mojave mud used for drilling fluid plasters the wall of the hole rapidly and thoroughly. This plaster, however, becomes like a stiff gelatin and is very difficult to wash off, especially after a liner has been set. The sand itself is loose and porous and the mud adheres to it readily.

When completing the wells by washing, as was done with the older wells in the Fruitvale field and with some of the newer ones in that field and in the Weed Patch and Edison fields, the liner is first washed and the well then swabbed. Frequently the well does not come in after this procedure; so it has to be washed again, the washing being continued, in several cases, from ten to 15 days.

The practice of scraping the sand was first tried in the Fruitvale field and after the success obtained with it there, is being even more widely used in the Weed Patch and Edison fields. In general, this method consists of scraping the hole through the producing formation, setting a liner, and then swabbing. The scraping requires about one day or less and the wells generally come in with one or two swabs.

Of considerable interest is the greater initial production that has accompanied wells brought in by scraping the sand. In the Edison area, for instance, wells coming in with from 75 to 100 bbl. of oil per day when completed by washing have been offset by 600- to 700-bbl. wells completed by scraping. One well was washed and then swabbed for three days but it was felt that a production of 100 bbl. per day could not even be obtained by pumping. The sand was therefore scraped and the well flowed 550 bbl. per day. This increase in production adds to the value of the wells while the scraping process itself is considerably less expensive than the washing method.

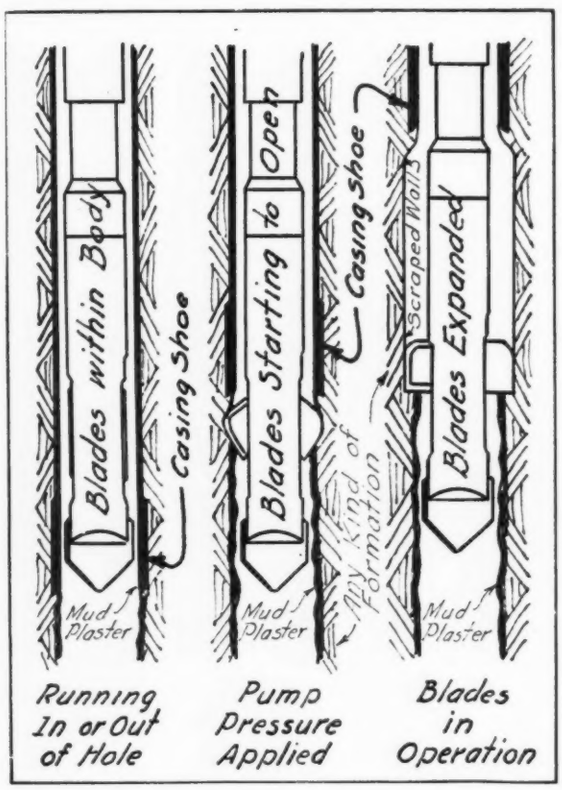
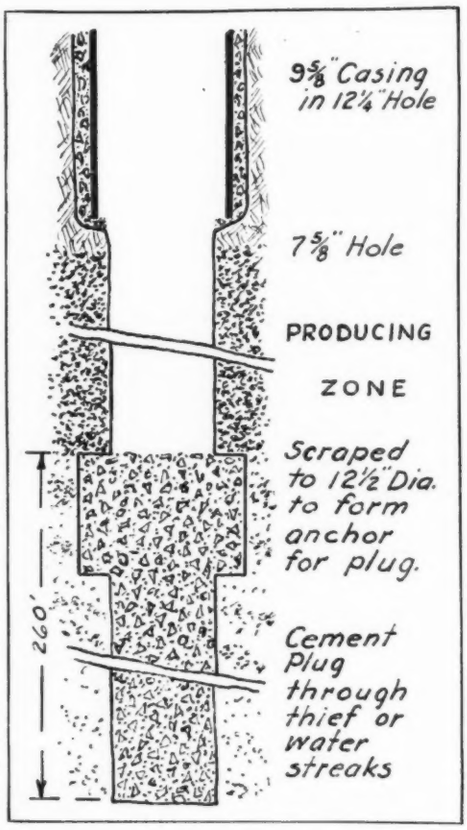


Fig. 3. Recess provided for cement plug to prevent upward movement


9⅝" Casing in 12¼" Hole
7⅝" Hole
PRODUCING ZONE
Scraped to 12½" Dia. to form anchor for plug.
260'
Cement Plug through thief or water streaks

The producing zones in the Fruitvale and Weed Patch fields are somewhat similar, although the depths are different. Production from the Fruitvale area is from wells that are about 3600 ft. in depth, while in the Weed Patch the wells range from 5100 ft. at the southeast end to 5600 ft. at the northeast, with the average being about 5300 feet. Some geologists believe that the Weed Patch is an extension of the Fruitvale field. There are hard streaks in the sand in both but these Marine deposits are found to be composed of larger masses in the Fruitvale field and smaller masses in the Weed Patch field.

Completion Methods

Two general methods have been used to complete the wells drilled in this district. One is to set and cement the water string before going through the sand; the other is to rathole to bottom and then set the water string. A test for water at the first encounter with the oil sand is usually made with a formation tester and it is seldom that the casing is set before such a test is made. Scraping of the sand is, of course, done after the water string has been cemented and the water shut-off test made.

While details of methods naturally vary with different companies, the accompanying drawings, Fig. 1 and Fig. 2, illustrating two wells drilled in the Edison area, will indicate the general procedure used when completing by scraping. At doubtful or wildcat locations, ratholing with only the surface string set is frequently done. The use of a formation tester before setting pipe will here sometimes enable the saving of a string of casing. Since the fields are so spotted, a great deal of whipstocking is often done; and in many cases, the kinks are enlarged by scraping.

As shown in Fig. 1, the surface string was cemented from both top and bottom, that portion of the cement used at the top being

Fig. 4. Sketch illustrating operation of wall scraper that expands by hydraulic pressure of fluid in drill pipe

Cementing through tubing around the upper end of 13⅜-in. surface string in a well in the Edison field

pumped in through a joint of tubing inserted behind the casing and that at the bottom being pumped around the shoe in the regular way. A 12¼-in. hole was then drilled to about one foot in the sand and the sand tested for water with a formation tester. In the well shown, anchors for the cement column behind the water string were provided for by scraping out the 12¼-in. hole to 15 in. near the shoe and at a point calculated to be near the point to which the cement would rise.

The 8⅝-in. water string was then set and, after the water shut-off test was made, a 7⅞-in. hole was cored through the sand to the total depth. The sand was then tested by the formation tester, after which it was scraped from 7⅞ in. to 9 in. in diameter. A 6⅝-in. liner was run to within a foot of bottom. This liner was 91 ft. in length and the portion below the water string was perforated.

In cementing the water string, the casing is often run very close to the bottom and left there until the first plug hits. It is then raised from 10 to 20 ft. where the cement job is completed and the casing left. The upward movement of the pipe is felt to give greater assurance that cement will completely surround it.

In the well illustrated by Fig. 2, the surface string was cemented in the same way as described above. A hole was then drilled with a 12¼-in. bit for about 4000 ft., when it was reduced to 7⅞ inches. The well was then ratholed from 5100 ft. to its total depth of 5500 ft. with the sand being picked up by coring at about 5500 feet.

After being reamed to just above the top of the sand, the productive zone was tested for oil with a formation tester and 8⅝-in. casing was run in and cemented at 5500 feet. The sand was then scraped from the water string to bottom and 60 ft. of 6⅝-in. liner set on bottom.

A string of 2½-in. tubing is used in all the wells and the wells flow through this tubing. The gas pressure is insufficient to flow the oil through the casing although in one exceptional case, where the tubing became clogged, the well flowed from between the casing and tubing.

Due to the tapering off of the productive sands and the presence of thief or water sands in the lower portion of the productive zone, quite a large percentage of the holes have to be plugged back before being completed. In a number of cases the plugs have moved upwards after the cement has set and have caused considerable trouble. To overcome this, one company used the method illustrated to anchor the plug down.

In this well, a 7⅞-in. hole had been drilled 260 ft. below where it was finally determined that the lowest production could be obtained. About 25 ft. of formation below the point determined as the top of the plug were then scraped out to provide a recess and to give a shoulder to prevent any upward movement of the plug. This is shown in Fig. 3.

Scraping the Formation

The scraping of the holes as shown in the illustrations was done with a Baker Rotary Hydraulic Expansion Wall Scraper. The procedure was, of course, an underreaming operation but the amount of enlargement of the hole that is possible with this tool offers an opportunity for extensive cutting away of the face when it is so desired.

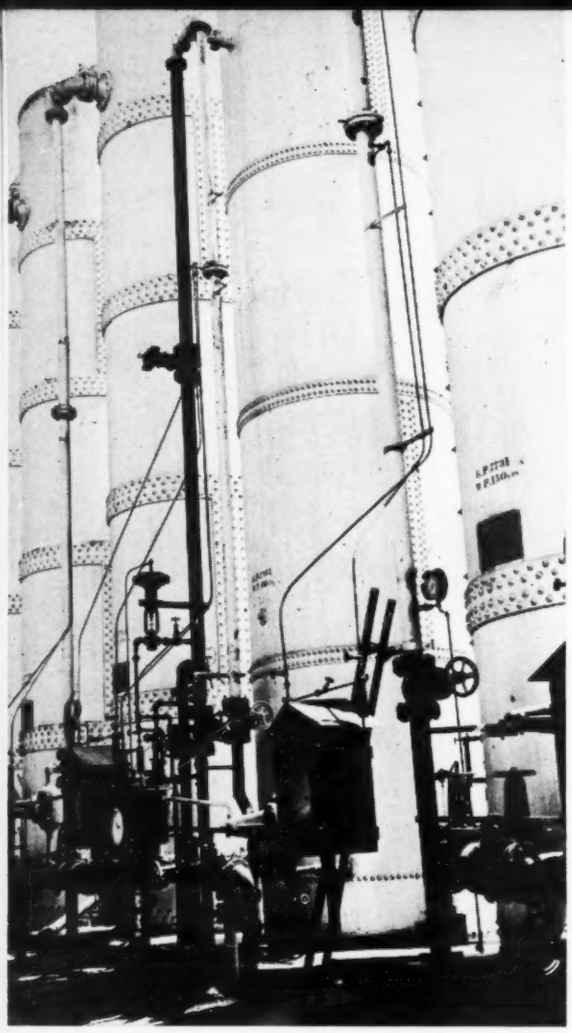
The operation of the wall scraper is indicated in Fig. 4. The cutting edges are provided by scraper blades that are expanded by pump pressure when the point at which the scraping is to be done is reached. These blades cut their way up to a horizontal position while the string is being rotated and are then held in position (after their full gauge has been obtained) by the shoulder formed in the formation.

When the program provides for a 6⅝-in. liner with a 8⅝-in. water string, the general practice in Fruitvale, Weed Patch, and Edison is to enlarge the 7⅞-in. hole to 9 in. by scraping. Where a 8⅝-in. liner is to be set, a 9⅝-in. hole is generally drilled and this scraped to 12½-in. diameter. In some cases, a 12¼-in. hole is drilled all the way through the sand and when this is done, not much more than the mud is scraped off, with the finished hole being 12½-in. diameter.

Water is scarce in this district so the top of the drilling mud alone is taken for circulation when running the wall scraper. This mud, however, is almost devoid of solids and does not plaster up the walls, leaving the sand face without obstruction to the ingress of the oil to the hole.

The blades are readily expanded after passing out of the casing with a pressure of about 100 lb. per sq. in.; and after they are once open and the reaming operation begun this pressure is cut down. Under average conditions and with the thickness of the sand penetrated for production in this area, it usually takes about one tour and one set of blades to complete the job of scraping the sand.

Hydraulic wall scraper as it came out of hole



Showing location of low-pressure vapor absorber. Natural gasoline plant of General Petroleum Corporation at Santa Fe Springs, California

Absorption Pr

Absorption pressure changed from 35 lb. to 150 lb. to meet field conditions — Rich oil from absorbers now vented twice — Still fractionation accomplished by "refluxing" the columns with stabilized gasoline

A NATURAL GASOLINE PLANT being operated by the General Petroleum Corporation at Santa Fe Springs, California, was the largest of its kind before that field was prorated. This plant has manufactured in excess of 225,000 gal. net of gasoline per day. To handle the large volume of gas coming at that time from the casingheads, field separators, and controls at the wells, 64 twin-cylinder, 165-hp. Cooper-Bessemer gas-engine-driven compressors were required to compress the gas not available at an original pressure sufficiently high that it could be introduced into the absorbers at the prevailing operating pressure of 35 lb. gauge.

All the wells in that area are now operated according to the proration regulations affecting the Santa Fe Springs field. Because of this, the volume of wet gas, as well as the quantity of oil produced, is far below the potential production. The method of producing the oil and gas varies according to the depth and condition of the wells. Oil and gas are both produced from a number of sands found at depths from 4000 to 8000 feet. Because of the greater depth of some of the wells and the amount of water being produced from others, both beam-pumping and gas-lifting are being used on wells that have ceased to flow naturally. To produce wells by the latter method the General Petroleum Corporation converted the units in two of the engine rooms, each containing 12 twin-cylinder compressors, by installing gas cylinders of the proper size to permit two-stage compression.

Wet gas at the time of writing is received from the wells at low pressure, requiring normally only 28 of the compressors to draw the gas from the separators, casingheads, and flow tanks on leases from which the company receives this raw material. A standby engine room containing 12 additional units is maintained for emergency service, because of the fact that the volume fluctuates from time to time. This is caused, as in any other field under proration and operated by gas lift, by a number of wells being produced simultaneously, while at other times, several wells are idle with a resulting lower volume of wet gas.

When the field was comparatively new and the plant was operating on the low pressure of about 35 lb., all the gas was compressed by the 64 twin-cylinder compressors and introduced into a battery of nine absorption columns. When the decision was made to place a number of the wells on gas-lift, higher pressures were necessary, so a battery of compressors was changed to fit the new requirements. At that time, markets for dry residue gas were also developed, and higher pressures were necessary to introduce the fuel gas into the gathering mains of the transportation companies operating in Southern California.

The headers serving the battery of 28 active, and also the 12 standby compressors, take gas from three separate gathering systems; the north low-pressure intake, the south low-pressure intake, and the vacuum intake. The average volume at this writing and other items of interest are shown in the following table:

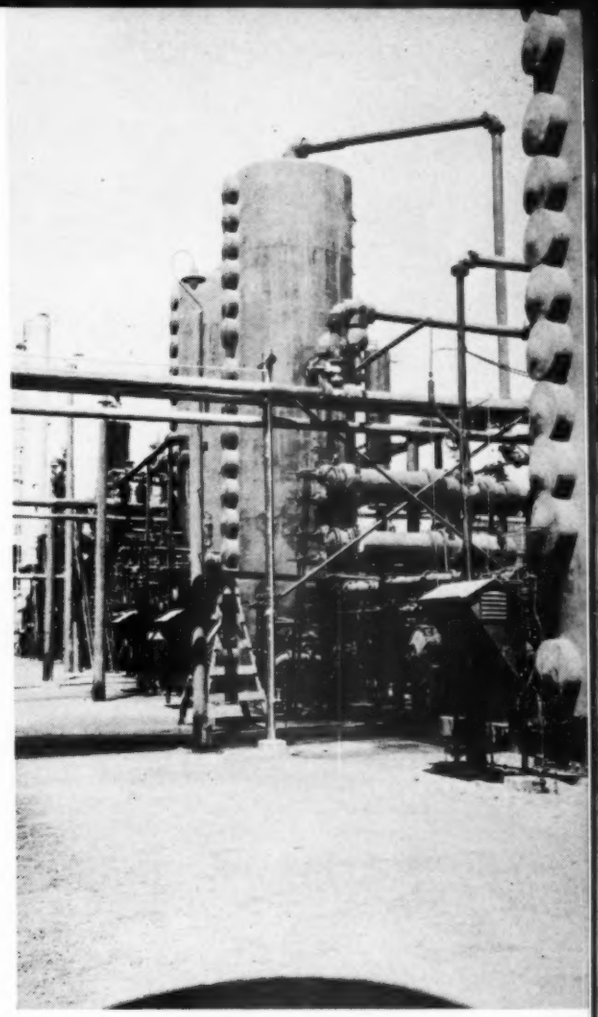
Wet Gas Potential

Source	*Gal./M. cu. ft.*	*Volume*	*Potential Gal.*
North Low-Pressure Intake	2.290		
(Corrected for water vapor)	2.365	9,033,000 cu. ft.	21,363
South Low-Pressure Intake	1.470		
(Corrected for water vapor)	1.518	6,957,000 cu. ft.	10,561
Vacuum Intake	5.920		
(Corrected for water vapor)	6.492	1,727,000 cu. ft.	11,653
TOTALS—(average)	2.437	17,717,000 cu. ft.	43,136

The above table is prepared semi-monthly from a regular analytical survey of all plant operations, and the comparison is always before those interested so that the results may be checked against any previous half month.

By manipulating the various units of the plant when it became necessary to place the gas through three stages, it was found to be more economical to absorb at an elevated pressure than to maintain the several absorbers in operation as was necessary when the lower pressures were used. Only two of the original nine are now in active service, processing the wet gas from the field. Other economies were placed in effect, one of which was that a smaller number of pumps was required, due to the lesser amount of oil circulated, thus placing a lower demand on boilers supplying steam.

The battery of 28 active, together with the 12 standby, engines, draws the gas from the field and operates as the first stage of compression, raising the discharge pressure from an intake pressure of atmosphere or slightly higher, to about



Row of Braun fractionating stills. Natural gasoline plant of General Petroleum Corporation at Santa Fe Springs, California

Practice in a Large Gasoline Plant

By

J. C. ALBRIGHT

35 lb. gauge pressure. The gas is cooled at this pressure stage in Braun atmospheric gas-cooling sections, after which it is scrubbed to remove the condensate. It is received again by compressor cylinders placed on the low side of battery of 24 twin-compressor units, increasing the pressure to 150 pounds. At this stage, it enters the absorbers with a temperature of about 86 deg. fahr., having been intercooled between the intermediate stage and the absorber inlet. The outlet of the gas from these absorbers does not show a significant increase in temperature as in most plants, being in this case a difference of only one deg. fahrenheit. The residue, or stripped lean gas leaving the absorbers, is again received by the compressors and boosted to about 350 lb. for gas-lift purposes as well as to enable it to be introduced into the transmission lines of the gas distributing companies.

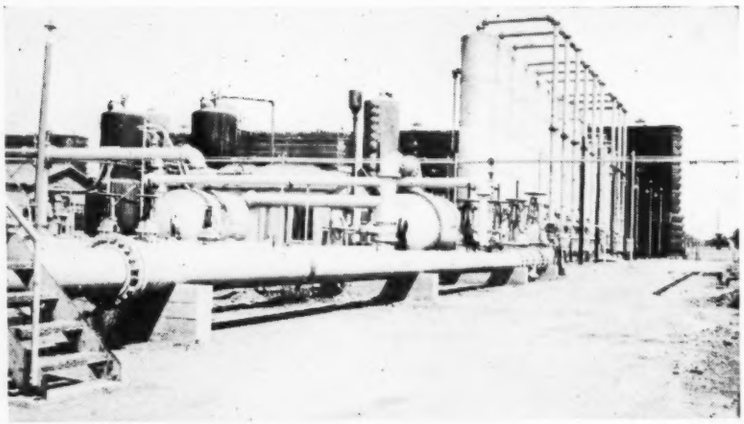
The absorption oil, a product manufactured by the company in its Torrance and Vernon refineries, has a close-cut boiling range with an A.P.I. gravity of about 40 degrees. After having been in contact with the wet gas in the absorbers under the operating pressure of 150 lb., the absorption oil naturally contains a considerable amount of the lower boiling fractions. At this point of operation in the Santa Fe Springs absorption plant, it was discovered that certain changes should be made to conform to the conditions brought about by absorbing under the elevated pressure—changes that were not necessary when the lower pressures were used.

Conditions surrounding the operation of the plant when absorption was carried out at about 35-lb. pressure permitted venting of the rich oil directly from the absorber oil outlet to the regulation Braun vent tank, which was carried at about six lb. above atmospheric pressure. This method of venting had been found to be reasonably satisfactory when the initial pressure applied to the absorbers was only 35 lb., but when the pressures were raised, vapors in large quantity escaped from the oil, and placed not only an undesirable increased load upon the compressors, but also carried more desirable fractions with them that must be reabsorbed again.

By experimenting with the plant, and by carrying out laboratory analysis of the various gases while being absorbed at both the low and high pressure, it was found that if the rich oil were vented twice, better results could be obtained. Following up this idea, developed from studying the plant, the rich oil is now vented from the absorbers through two stages. Coming from the liquid level controllers under a pressure of approximately 144 lb. gauge, the oil is introduced into a primary vent tank operated at a pressure of 50 lb., from which those fractions that are normally gaseous may escape. When venting in this manner, it was found that only a very small percentage of normal butane was carried from the rich oil by the gases released from the vent tank. This vented gas is picked up by the absorbers taking suction on the scrubbers after the first stage of compression, and are returned to the absorbers for treatment again. By selective absorption, these light vapors are finally removed from the absorbers with the stripped residue gas and enter the third stage of compression to be shipped out as fuel, or used in gas-lift operations.

After the rich oil has been vented through this primary tank, it is directed to the receptacle used when the pressures were lower on the absorbers. A pressure of only six lb. is maintained on this Braun rich oil vent tank, and the vapors released through the overhead line enters the intake of the first-stage compressors and passed through the system again. By applying this principle to venting, it was found that not only was there a considerable saving effected in compression, but a large portion of the lower-boiling fractions remained in the oil.

Another thing was discovered that had an influence on the effective stripping of the gas in the absorbers. At the time of writing, an oil to gas ratio is carried out that provides approximately 34 gal. of oil circulated to each thousand cu. ft. of wet gas. Other ratios have been tried, higher and lower, but the most satisfactory results have been obtained with 34 gallons. When a higher oil-gas ratio was used, a larger amount of undesirable fractions that could not be used in the manufacture of natural gasoline were removed from the gas by the absorption oil, and when venting this supersaturated oil through the primary vent tank, a large recycle volume was built up that overloaded the compressors with useless work. When a lower ratio was tried, a small portion of the n-butane was passed out with the dry residue



Absorber battery scrubbers and lines. Natural gasoline plant of General Petroleum Corporation at Santa Fe Springs, California

gas, a material that is necessary at Santa Fe Springs to maintain a vapor pressure of approximately 24 lb. Reid, on the finished product leaving the fractionator unit.

As the volume of wet gas processed in this plant fluctuates over quite large ranges, the plant operators have been furnished with an oil-gas ratio chart that guides them in controlling the oil pumped to the absorbers. By watching the orifice meter charts that record the various volumes, pressures, and temperatures, they are able to adjust the amount of oil entering the absorption columns to conform to the fluctuating gas load. No other changes are made when this occurs, because the greater or smaller quantity of oil—as the case may be—pumped to the absorbers maintains a balance throughout the plant, because all other flows are automatically controlled.

A Summary of Research Plant Control is Shown Below:

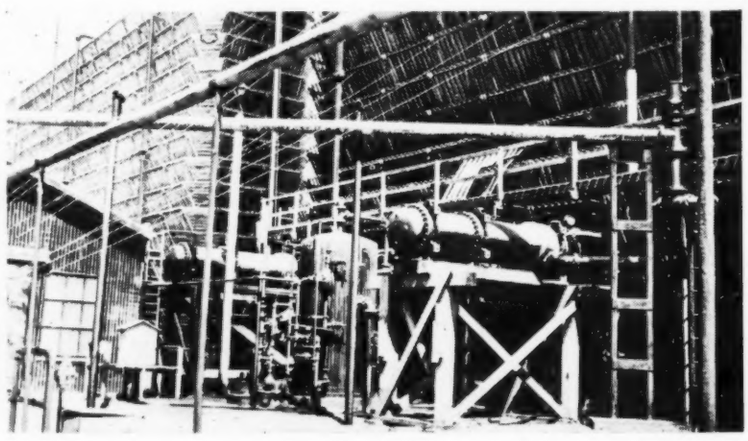
	Absorber No. 3 11:00 A.M. and 2:15 P.M.	Absorber No. 4 11:00 P.M. and 2:15 A.M.	Totals
LEAN OIL RATE			
At time of test	211	210	452
24-hour average	208	208	445
LEAN OIL TEMPERATURE (deg. fahr.)			
At time of test	82	82	82
24-hour average	78	78	
DRY GAS VOLUME (M. cu. ft.)			
At time of test	8,033	8,033	16,066
24-hour average	7,931	7,931	15,902
WET GAS VOLUME (M. cu. ft.)			
At time of test	8,950	8,950	18,900
24-hour average	8,836	8,881	17,717
OIL/GAS RATIO (Gal./M. cu. ft.)			
At time of test	34.0	33.7	33.9
GASOLINE CONTENT OF DRY GAS (Gal./M. cu. ft.)			
At time of test (charcoal)	0.06	0.05	0.055
At time of test (fractionation)	0.106	0.106	0.106

After the oil has been vented to the pressure of six pounds in the secondary tank, it is picked up at that pressure and changed to the fractionating stills, which are operated at a pressure of 35 lb. gauge. The temperature of the oil is substantially the same from the secondary vent tank as when it was released from the absorbers, but after passing through the bank of Braun heat exchangers and the Braun steam-operated preheaters, the temperature has been elevated to about 325 deg. fahrenheit. Entering the still at this temperature, it falls slightly as the oil in the columns is only 320 deg. fahrenheit. Passing out of the still after it has been satisfactorily stripped of the gasoline, the oil flows counter-current to the rich oil in the exchangers and travels through Braun atmospheric sections to be pumped to the absorbers again.

The vapors from the fractionating still are treated a trifle differently from the usual method. Refluxing to the required temperature is usually accomplished either by pumping primary condenser distillate, or raw unstabilized gasoline back over the still. In this plant, however, finished gasoline having a recovery of 96 per cent or better is used as fractionating still reflux. The idea back of this method is that as the reflux material is free from propane and iso-butane, the overhead fractions will be brought to a better end-point than if raw, unstabilized gasoline were used as reflux. Furthermore, the load imposed upon the vapor condensers is considerably less when this stable product is used, than if a considerable portion of low-boiling fractions were pumped to the reflux sections of the stills.

The gasoline vapors from the stills are condensed in Braun atmospheric admiralty metal tube sections, after which they travel in a split stream through two Braun shell and tube after-coolers, or supplementary condenser units. The stream is received in a regulation accumulator tank, from which it is continuously being pumped through a float-controlled pump to a supply tank. From this vessel, it is charged to the fractionator for processing to a 24-lb. Reid, finished product having a recovery of 96 percent or better, as indicated by an Engler distillation test.

The vapors from the run tank that are not condensed are transferred back to the absorber battery, where they are contacted in a vapor absorber, separate from the high-pressure units, to extract the desirable fractions not condensed in the atmospheric sections. Unabsorbed gases from the vapor absorber that are not taken up by the circulating absorption oil are vented into the line carrying the released gases from the secondary vent tank and returned to the two principal absorbers for final treatment.



After-coolers or supplementary sections through which gasoline is passed to the accumulator tank below. Natural gasoline plant of General Petroleum Corporation at Santa Fe Springs, California

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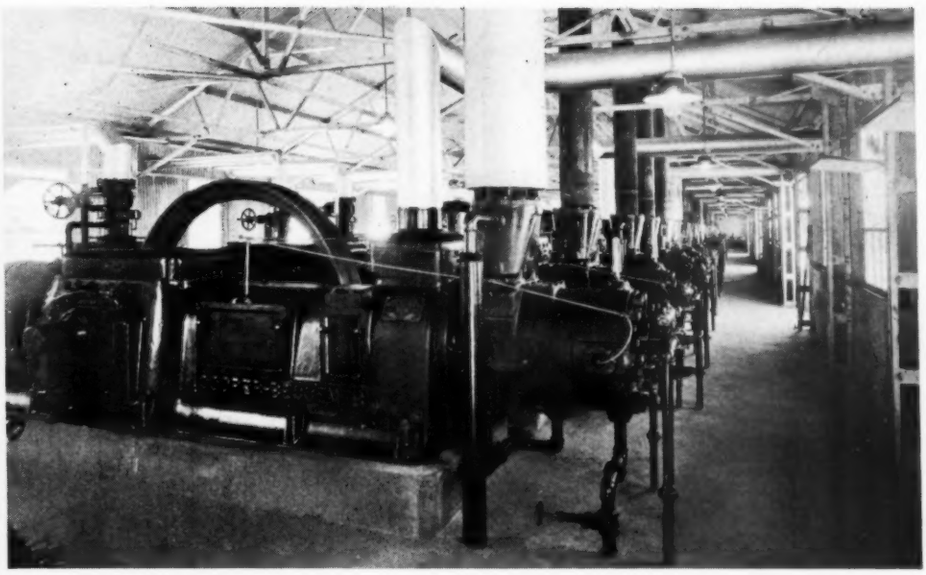

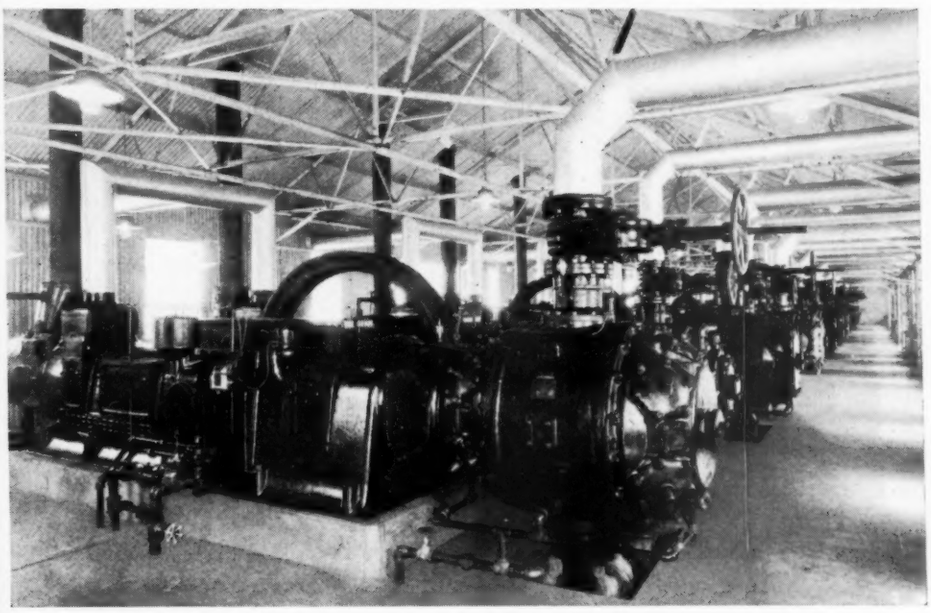

IN selecting Cooper-Bessemer units for this modern plant, the Sabine people knew what they wanted — the best! It was not a question of price . . . instead, they considered the costs over a period of years. Performance has been even better than we expected! And the plant has exceeded its capacity guarantee by a wide margin.

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The Manufacture, Packaging, and Shipping of Oxidized Asphalt

By
CHAS. J. HOLLAND

Article 9

IN the concluding paragraph of Article 8 it was stated that there were four commercially practicable means for accomplishing mechanical agitation of the liquid and gaseous bodies within the stills of a continuous asphalt oxidizing unit. These were listed and will be here repeated but before doing so, it is well to remark:

That mechanical agitation is all the writer claims it to be (see discussion of Principle No. 9, Article 7) is indirectly confirmed by Bell in "American Petroleum Refining," p. 114. Though he had no experience with continuous oxidizing asphalt units and probably never even heard of mechanical agitation thus utilized, he shows nevertheless his marked appreciation of it in horizontal crude oil shell stills, as follows: "It has been found that about six B.t.u. per sq. ft. per hr. per deg. difference in temperature between flue gases and oil in the still is about the limit of heat that the boiling oil can conduct away from the plate. This is explained by the low specific heat and sluggishness of convection currents in oil. When mechanical means are employed to set up induced currents that cause the oil to sweep the still bottom, records show that the heat input per sq. ft. may be increased three to four times with a corresponding increase in distillate yield per sq. ft. of evaporating surface."

The four commercial means for obtaining the benefits of mechanical agitation are:

(1) Use of the Turbo-Mixer.

(2) For each still an outside pump recirculating system.

(3) The Internal Reflux system.

(4) Plant No. 1 type of stirring device.

The Turbo-Mixer

So far as this writer could find out from over two years of correspondence and contacts with representatives of the manufacturer and from talks with disinterested experts, no one knows from experience just what a Turbo-Mixer will do. That it is a mixing machine of extremely high efficiency for solids, liquids, and gases almost everybody knows; that it is probably two efficient and too costly for continuous asphalt oxidizing is the opinion the writer holds (but he has no experience data whatsoever to substantiate this opinion); that to know for certain, apparently one must buy, install, and use one for several months in a commercial unit.

From correspondence the writer did find, however, one refinery equipment building firm quite enthusiastic in this connection though he was not able to procure from this firm any comprehensive experience data. In May, 1934, the firm wrote to the writer as follows:

"We are attaching blueprint sketch of a scheme that we believe has considerable merit over the eight stills that you have indicated you were considering using. We know that this scheme on a smaller basis is working in a plant in Southern France very satisfactorily and offer it as a suggestion.

"You will note from this that the flux is taken from storage through a still to where it is raised to 500 deg. fahrenheit. From there it passes through the three blowing tanks as shown, these tanks being in series. The most efficient agitation obtained today is using on a vertical shaft, an impeller very similar to a centrifugal pump impeller at the circumference or discharge edge of which stationary diversion vanes are installed, this arrangement being driven by a vertical electric motor with proper reducer—integral with the motor unit.

"Air is admitted at the bottom of the tanks and passes up with the charge through the impeller, out through the diversion vanes. By making four or more draw-off points the time element in each tank can be quite accurately controlled, this being very important in oxidization. After passing through the three tanks in series and withdrawn from the last, it can be directly barrelled and carried to storage.

"A tower is connected with the vents for recovering the oils driven off during the oxidization process as well as arresting the fumes by washing.

"You no doubt will immediately see the merit of this arrangement over the series of vertical tanks as you have suggested. The optimum oxidizing temperature is around 500 deg. fahr., with an allowable variation of plus or minus five degrees. The temperature can be controlled in our arrangement by controlling the amount of air to each tank and controlling the time allowed in each tank.

"For batch operation the following are average figures: 4½ cu. ft. of air per min. per bbl. of charge during blowing operation.

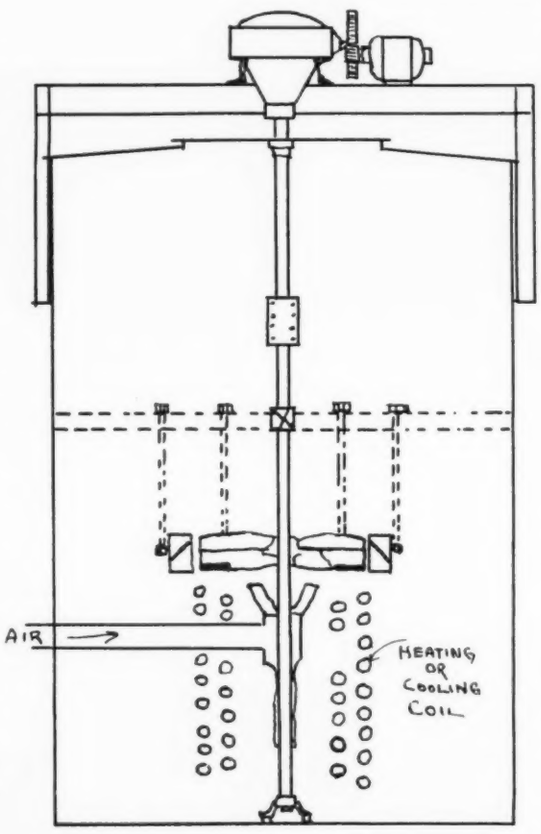

Fig. 14. Turbo-Mixer in a vertical still

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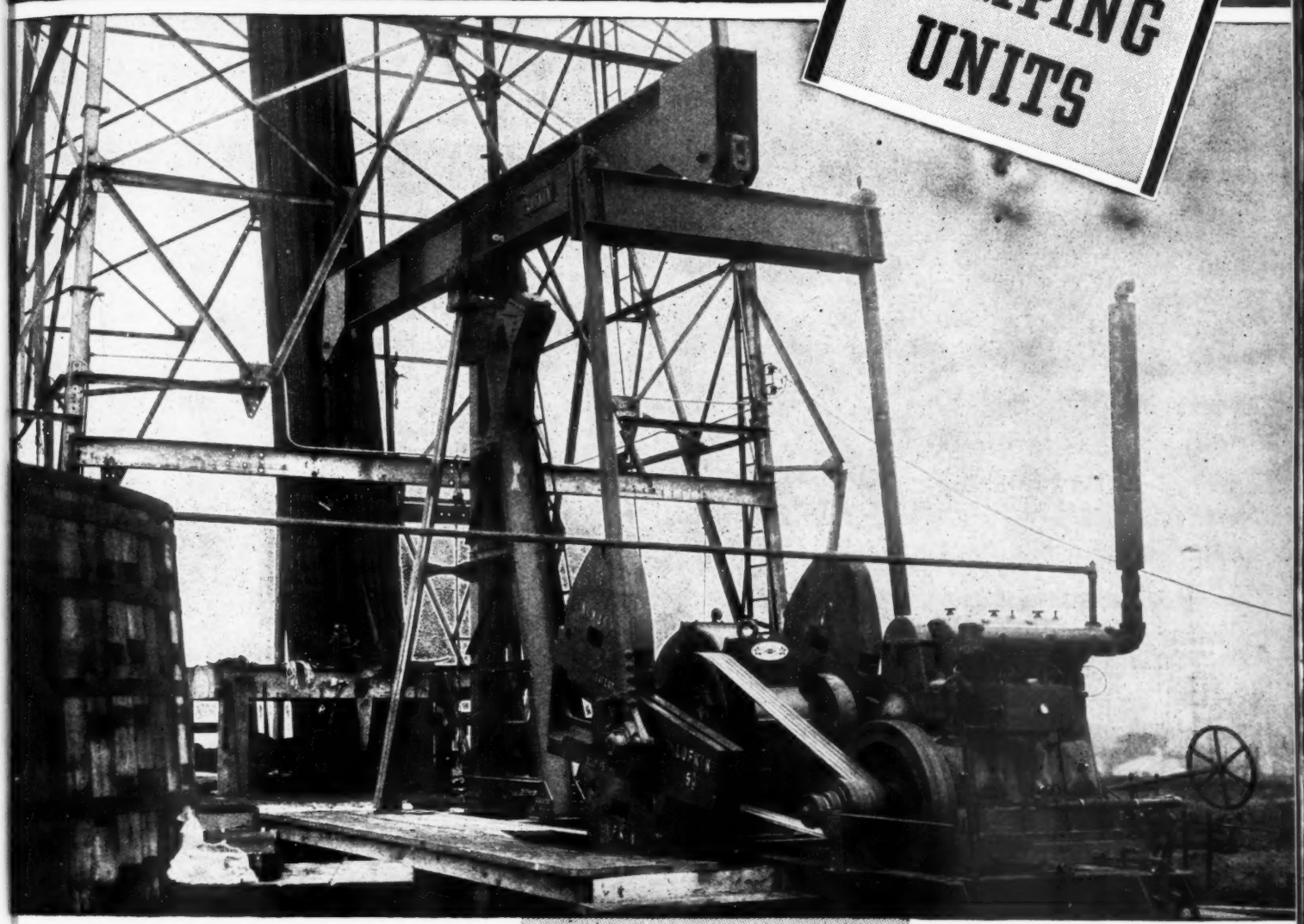

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Blowing time:

160 deg. fahr. M.P. - - - -	8 hours
185 deg. fahr. M.P. - - - -	11 hours
220 deg. fahr. M.P. - - - -	15 hours
300 deg. fahr. M.P. - - - -	30 hours

"If the process we have suggested is used, the amount of air per min. per bbl. of charge will be reduced and the time of blowing to the point of where the temperature does not increase above the optimum stated."

Fig. 14 illustrates the set-up of the Turbo-Mixer in a vertical oxidizing still. Fig. 15 is the diagrammatic sketch referred to in the above-quoted letter.

The two chief advantages claimed for the Turbo-Mixer are reduced air consumption and reduced cycle time. In both they have reference to batch running, an entirely different thing from continuous operation. Regardless of this, however, saving in air means little because total air costs will not run over five cents per ton of asphalt produced. On the other hand, and especially with asphalts of medium melting points (150 to 200) there is a distinct advantage in a plentiful air supply where internal reflux is not used. The advantage is that it removes from reaction zone much of the excess exothermic heat, thus allowing reaction to proceed at a faster rate; that is, it reduces cycle time.

As to the claim of reduced batch operating time cycle, the writer can and has done commercially the same thing by means of method No. 2, next to be discussed, which the writer believes to be cheaper in first, operating, and maintenance costs.

For Each Still an Outside Pump Recirculating System

In Baku some three years ago one of the old 1000-bbl. batch stills was taken and to it was hooked a recirculating pump and asphalt cooler. When maximum oxidizing was reached the pump was started up at rate of about 100 bbl. per hour. The asphalt being oxidized was thus pumped out, circulated through an asphalt cooling device, and returned to the still about 200 deg. fahr. cooler than when taken out. In this way the surplus exothermic heat was removed, allowing for faster rate of absorption of oxygen from the air while at same time affording a means of mechanical agitation.

The results were reduced air consumption by one-half and a 300 to 400 percent reduction in oxidizing cycle time. This is about the same as claimed for Turbo-Mixer. Though the writer has no figures, he believes the Baku method to be more practical and less expensive.

The Internal Reflux System

Use and expected results from employment of internal reflux system were explained and discussed under heading of Principle No. 10, Article 7.

Plant No. 1 Type of Stirring Device

In combination with (3) it is the writer's opinion the Plant No. 1 type of mechanical agitation is the most efficient, most practical, and the cheapest so far developed for a continuous oxidizing unit. This combination was therefore recommended for stills in Mexico.

It is evident improvements can be made in the Plant No. 1 paddle and chain drag stirring device. For example, there could be added second and third paddles of more efficient design. Another scheme is to use a hollow shaft through which the air would go, allowing air to come out through perforated hollow paddles. Thus an automatic whirl to shaft and paddles might be achieved, similar in fashion to an ordinary revolving type water lawn sprayer.

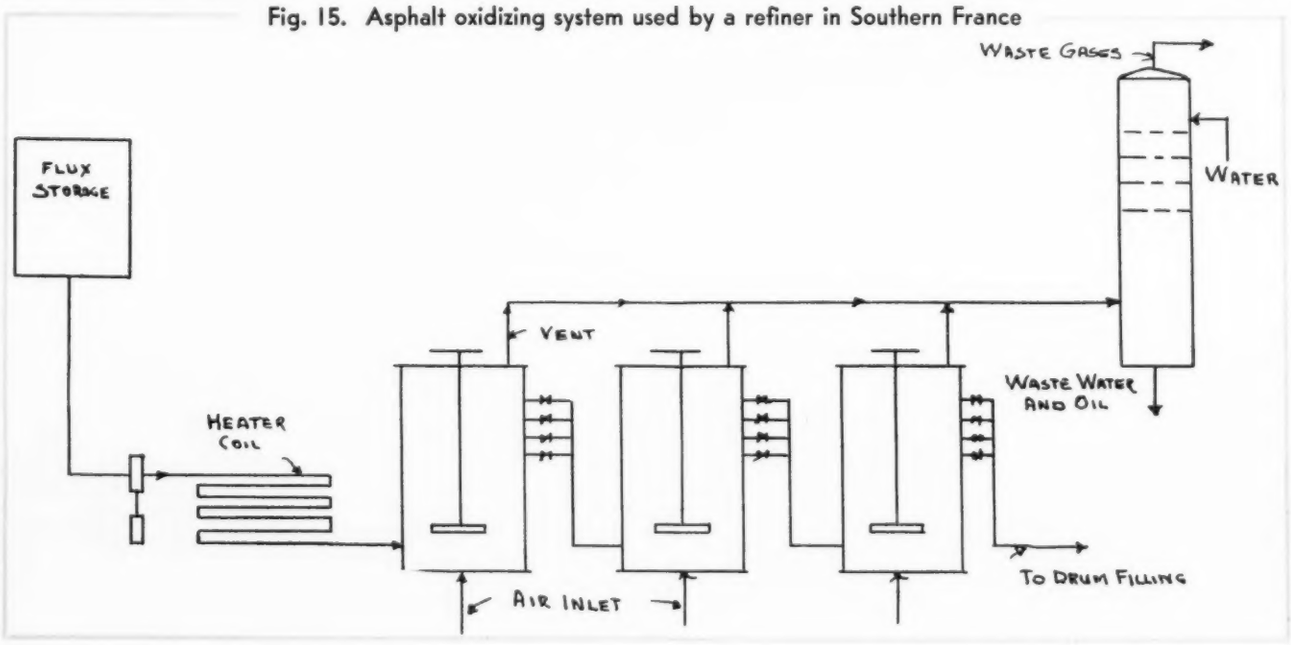
Concerning air spiders, the writer recommends the use of spiders as shown in Plant No. 1 drawings, keeping in mind the point about total area and size of perforations as used at Plant No. 2 (see Article 4). Here, too, improvements can be made. One would be the use of removable air spiders that can be cleaned without stopping and opening up of stills.

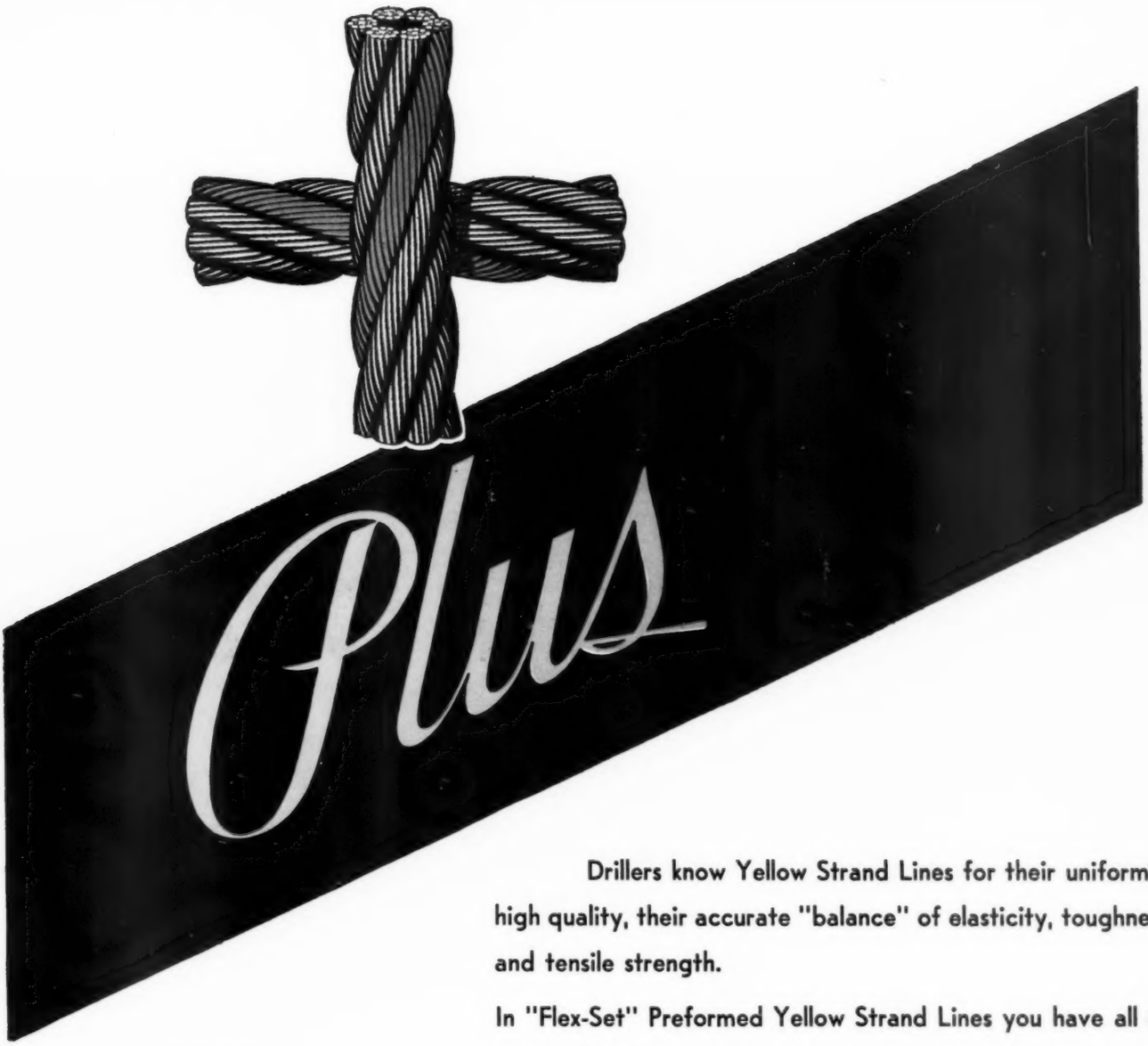
Use of Leeds-Northrup pyrometer of same type as at Plant No. 2 should be used for pipe pre-heater and stills temperature control. At the same time and at a close and accessible point, indicating long stem mercury thermometer wells should be installed for pre-heater and for each still.

If design shows practical, the flow-line should be located in rear of stills instead of in front as done on Plant No. 1. It will require one less platform and will be more convenient of operation and control.

For vapor lines and vapor disposal system the writer recommends following exactly the Plant No. 1 drawings and as described in Article No. 2. It is costly and involves erection of a stack 170 to 200 ft. high, depending upon plant topography and severity of municipal regulations as to fume nuisance from industrial plants. If regulations are not too strict a much cheaper system would be to erect for each still a vertical pipe 80 to 100 ft. from ground level. As told about in Article No. 2, we first had this on Plant No. 1 stills. It might have been improved with the fume nuisance made less offensive by use of water jets in each pipe upright.

Fig. 15. Asphalt oxidizing system used by a refiner in Southern France





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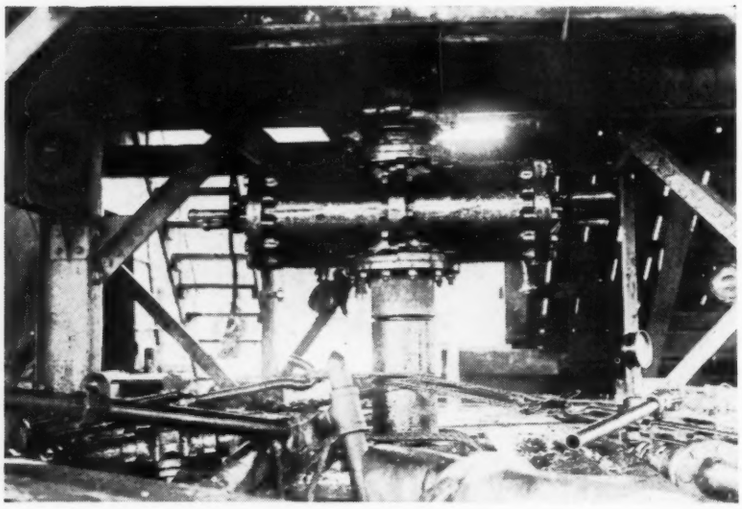


High-pressure oil saver and quick-change union below derrick floor on well in Fitts field being drilled under pressure.

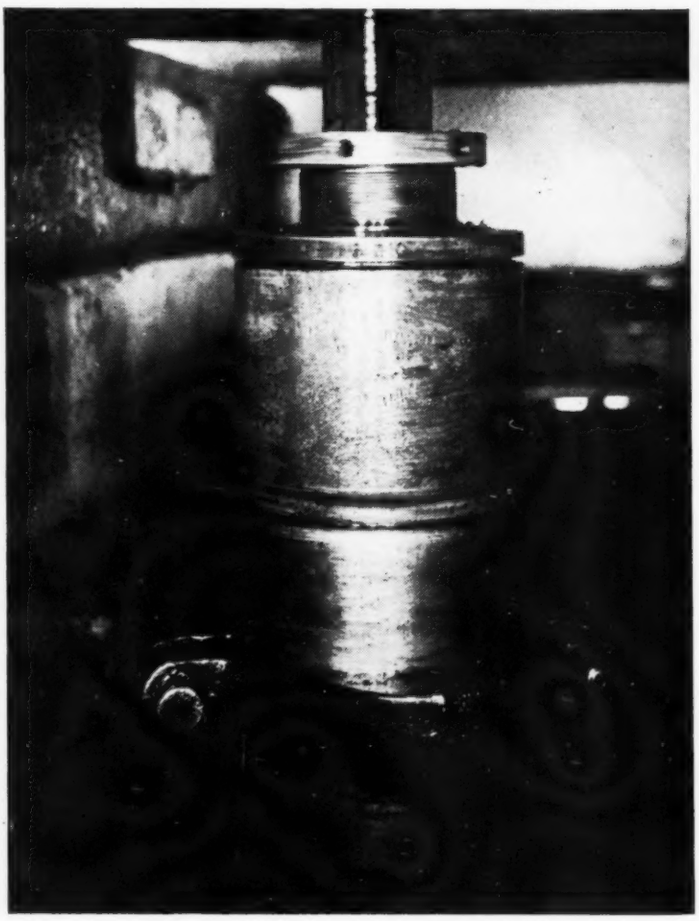
Practice of completing wells under pressure is finding wide application in Fitts and Oklahoma City fields—Self-aligning head is latest development in pressure control equipment

Pressure Drilling in Oklahoma

By JOHN S. ROSS

WHEN completing wells under pressure with equipment that will permit uninterrupted flow of oil and gas from the sands as drilling progresses, no mud ever reaches the face of the sands, thus eliminating the danger of clogging the producing horizons. This is of great importance when drilling into low-pressure oil sands and into highly permeable lime formations. In the Oklahoma City field, for example, the soft and very permeable Wilcox sand in the new extension zone now has a recorded bottom-hole pressure of less than 300 lb. per sq. inch. Since a column of drilling mud would exert a pressure equivalent to about 2700 lb. per sq. in., it is obvious that considerable penetration must take place; indeed, samples of the Wilcox sand obtained from a well while drilling in with mud, showed under a microscope a pulverized mixture of mud, sand, and shale, whereas samples from an offset well taken while drilling in under pressure showed uncontaminated sand. Even in the Fitts field, where bottom-hole pressures range from 1600 to 1800 lb. per sq. in., wells completed with drilling mud are not always satisfactorily cleaned by "washing in" as indicated at times by the presence of drilling mud produced with the oil for some time after completion.

Drilling in under pressure permits the pay zones to be accurately logged, for not only are the cuttings carried immediately to the surface but small increases in rates of flow of oil or gas can be promptly detected. Location of intermediate or bottom-water sands can be quickly noted and drilling stopped before further damage is done. Knowledge of the exact location and content of pay streaks and the character of the intervening formations is invaluable for plugging-back operations that may be necessary then or at some later date. This information is also of great value in determining oper-



Otis kelly drilling head on well in the Oklahoma City field.

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ating and casing programs, as is evidenced by the recent operator's agreement promulgated for the Fitts field, this agreement having been based upon data that were obtainable only through pressure drilling.

Drillers observe that they can make more hole and in a shorter time per bit by the pressure method than when drilling in with mud. This is mainly due to the fact that the hole is always kept clean of cuttings, and that cuttings do not settle around the bit when making connections or to bottom when making a round trip. The jet action of the gas across the face of the bit is also believed to be effective in removing cuttings, particularly while drilling in the soft Wilcox sand. Furthermore, when drilling in under pressure the well starts "paying off" the moment that the bit reaches the sand, because the customary delay caused by washing in, bailing, or swabbing, is obviated.

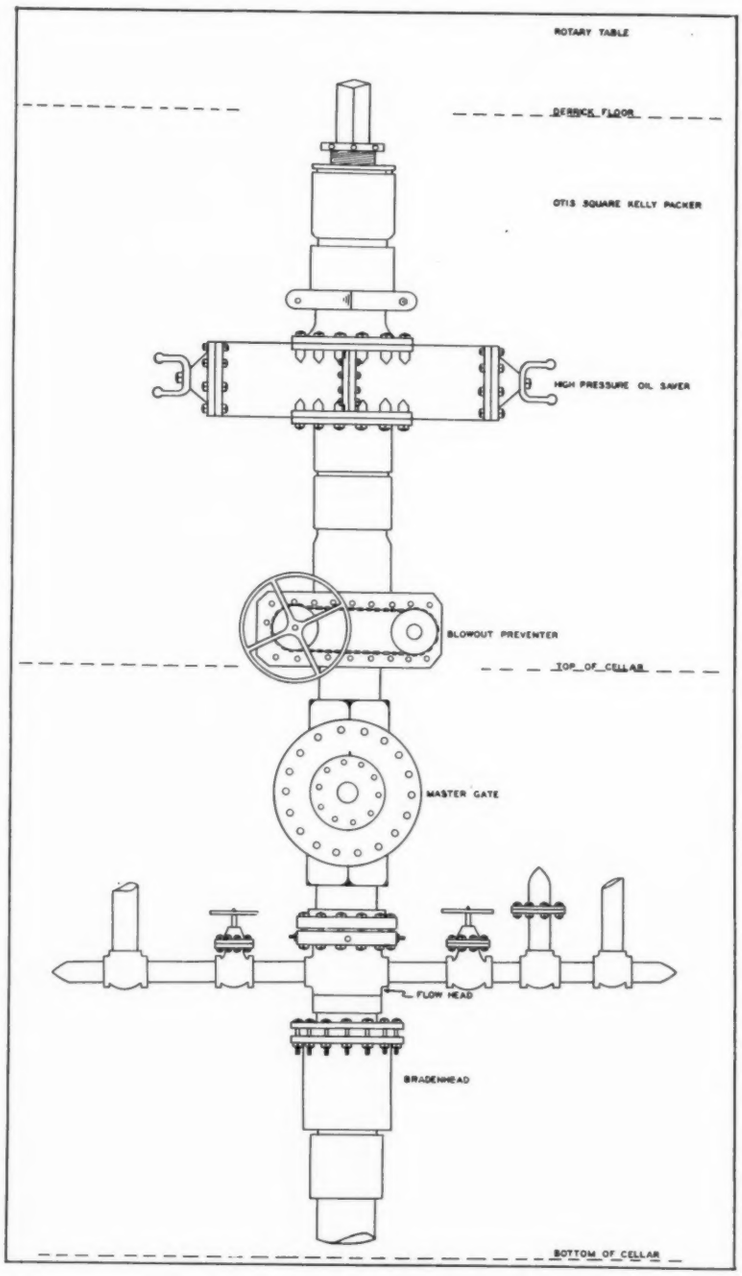
Drilling in under pressure control is now in wide use in the Fitts field and in the Oklahoma City extension zone. One method recently developed employs the same drilling rig used in drilling the well from the surface down to the point of casing, the customary outside-coupled drill pipe and the customary square kelly joint.

Packing around the rotating square kelly joint is accomplished by means of a fully self-aligning drilling head, which is coupled to a special high-pressure oil saver and blow-out preventer by means of a quick-union. This drilling head contains a core through which the kelly joint moves vertically, but which is rotated with the kelly through the action of drive bushings. One set of molded packing inside the core prevents leakage past the kelly, while another set of pressure seal packing placed between the core and its retaining bowl prevents leakage past the core. This latter packing is so constructed and placed that it maintains a seal around the rotating core regardless of any deflection from the vertical. Self-aligning bearings take up the vertical thrust of the core and permit it to wabble along with the kelly joint as the latter rotates. This self-aligning feature has been found to be essential, for kelly joints are almost invariably crooked and rotaries usually wabble to a certain extent; also, it is virtually impossible to maintain connections, rotary, and crown block in accurate alignment during drilling operations.

When a connection is to be made the kelly joint is raised its full length, permitting closing the oil saver or control heads around the drill pipe beneath it. The drilling head is then quickly uncoupled and raised through the rotary along with the kelly joint. Almost no time is lost in this operation. The drill stem is run into or pulled from the well under pressure through the oil saver, while the ram-type blow-out preventer beneath it acts as emergency equipment in the event of failure of the oil saver. Sufficient space is provided between the oil saver and master gate to allow for handling the reamer and bit. It is only seldom necessary in either of these fields to snub drill pipe in or out of the well. When necessary, however, it is accomplished with the customary equipment, which is maintained in these fields for this purpose. Usually there is ample space within a substructure for the above equipment, so that it is not necessary to block up the rotary.

Some operators employ a type of tubing head that permits landing the tubing under pressure beneath the gate valve and subsequent salvaging of the gate valve. Use of this equipment in conjunction with the above method has been found to be thoroughly satisfactory and to conserve space beneath the derrick floor.

In the Fitts field from 400 to 600 ft. of formations are drilled under pressure, commencing with the cement plug in the casing, set on top of the Viola lime, and extending through the Bromide or the McLish sands. Drilling is begun with an aerated column of water, which is circulated at the rate of about 350 bbl. an hour. Gas, under a pressure of about 500 or 600 lb. per sq. in., is injected in the stand pipe in the ratio of from 200 to 250 cu. ft. per barrel. Formation gas is usually picked up in the Viola lime and as this gas and the oil flow increases, oil is substituted for the water and the input gas reduced to about 125 cu. ft. per barrel. Production of oil during drilling varies considerably from one well to another. In the case of one well it was as high



Typical well hook-up in Fitts field for drilling with Otis square kelly drilling head.

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Unit Type Draw Works

No. 34·32·9·DMU

PORTABILITY: Heavy welded structural steel frame permits entire draw works to be moved as a unit.

BRAKES: Compound Equalizing capable of handling heaviest loads.

BRAKE RIMS: 54-inch diameter by 10⅜-inch wide water cooled brake rims furnished on order. Life of rims and lining and braking efficiency greatly increased by effective cooling of braking surfaces.

DRUM: 32-inch diameter by 35¼ inch long grooved drum with ample capacity for longest drilling lines.

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ROTARY DRIVE: From clutch sprocket mounted outside of bearing on Jack Shaft thru roller bearing idler sprocket on drum shaft. This affords unusually low drive to the rotary.

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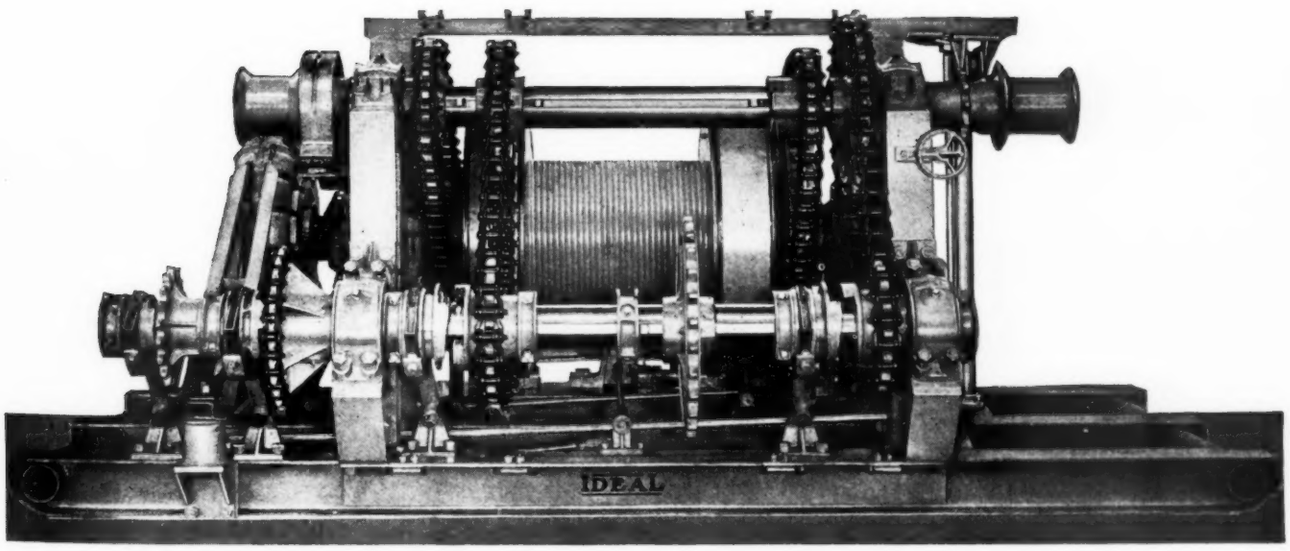
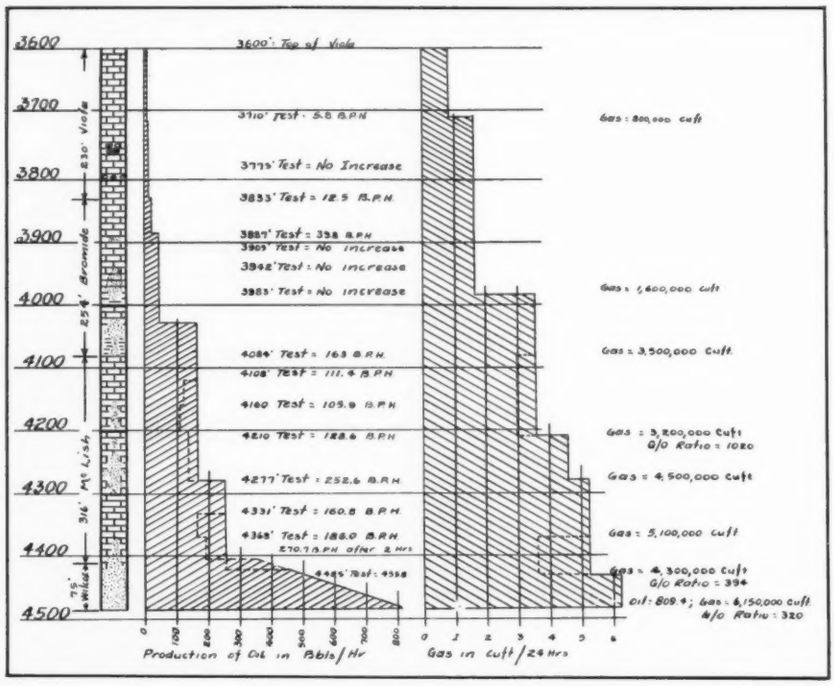



3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
3600' Top of Viola
3710' Test - 5.8 B.P.H.
3775' Test = No Increase
3853' Test = 12.5 B.P.H.
3887' Test = 338 B.P.H.
3905' Test = No Increase
3942' Test = No Increase
3983' Test = No Increase
4084' Test = 163 B.P.H.
4108' Test = 111.4 B.P.H.
4160 Test = 105.9 B.P.H.
4210 Test = 128.6 B.P.H.
4277' Test = 252.6 B.P.H.
4331' Test = 160.8 B.P.H.
4348' Test = 186.0 B.P.H.
270.7 B.P.H. after 2 Hrs.
4485' Test = 4558
230' Viola
254' Bromide
316' Mt. Lish.
78' Hunton
Gas = 800,000 cu ft
Gas = 1,400,000 cu ft
Gas = 3,500,000 cu ft.
Gas = 3,200,000 cu ft
G/O Ratio = 1020
Gas = 4,500,000 cu ft
Gas = 5,100,000 cu ft
Gas = 4,300,000 cu ft
G/O Ratio = 394
Oil: 809.4; Gas = 6,150,000 cu ft.
G/O Ratio = 320
0 100 200 300 400 500 600 700 800
Production of Oil in Bbls/Hr
0 1 2 3 4 5 6
Gas in cu ft/24 Hrs

Completion log of E. H. Moore's Atkins No. 3 Fitts field showing the data obtained by drilling in under pressure.

as 987 bbl. an hour. Back pressure on the well during drilling is maintained by stop-cocking between the well and the separator, and varies from normal separator pressures of from 25 to 75 lb. per sq. in. up to or greater than 350 pounds. Regardless of the amount of back pressure held on the well, it is desirable to maintain a fairly uniform pressure on the separator in order to steady the readings of the output orifice meter on the vent line and to dump the oil. A frequent check of the input and output meters and of the oil gauges gives an accurate record of the productive capacity of formations as they are penetrated.

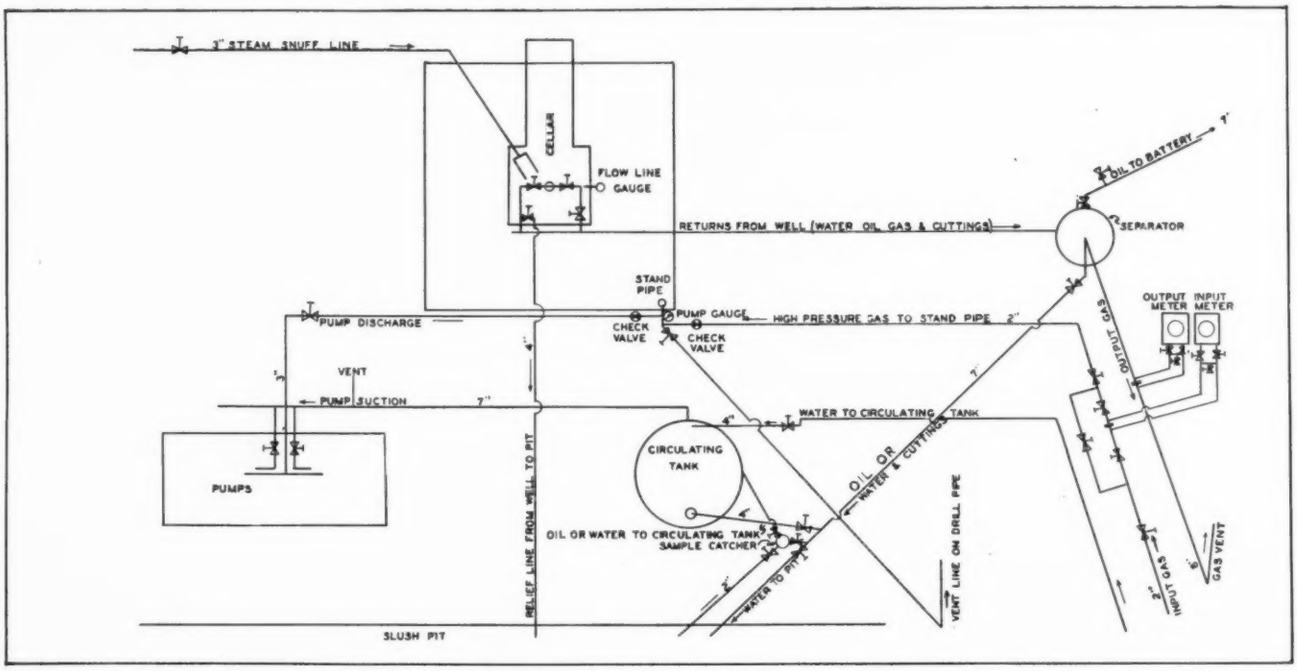
Owing to the difference in bottom-hole pressures the drilling procedure in the Oklahoma City field differs somewhat from that followed in the Fitts field. In the Oklahoma City field the cement plug is drilled with clear water, which is then blown out in stages by gas, and circulation of oil and gas established at the rate of between 20 and 40 bbl. an hr. and three to four million cu. ft. a day, respectively. When formation oil increases sufficiently to afford an adequate lifting medium the oil pump is shut down and only gas circulated through the drill pipe. This method has proved satisfactory for keeping the bit cool and for removing cuttings. Only enough back pressure is held on the separator to cause it to dump the oil. Sand cuttings are permitted to be carried with the oil into the stock tanks, where sand samples are collected and the oil is gauged periodically. Although the input gas is measured, no accurate record is kept of the output gas.

Drilling operations in the residential section of the Oklahoma City extension zone is under strict supervision of the city fire department, and because of the safety features involved where pressure drilling is used, this method of completion has received its approval. Danger of blow-outs due to loss of circulation is eliminated and there is no necessity for boarding up the derricks, as is the custom when the wells are bailed or swabbed in.

Twenty-two wells in the Fitts field and eight in the Oklahoma City field have been completed with equipment using a square kelly joint, pressure-drilling head, and ordinary drill pipe provided with regulation tool joints. Both the 3-in. and the 4-in. drill strings are being used in these fields.

In addition to those now drilling, it is anticipated that eventually all wells to be completed in the Oklahoma City field and most of those to be drilled or deepened in the Fitts field will be drilled in under pressure control.

Typical flow diagram for pressure drilling in Fitts field, Oklahoma.



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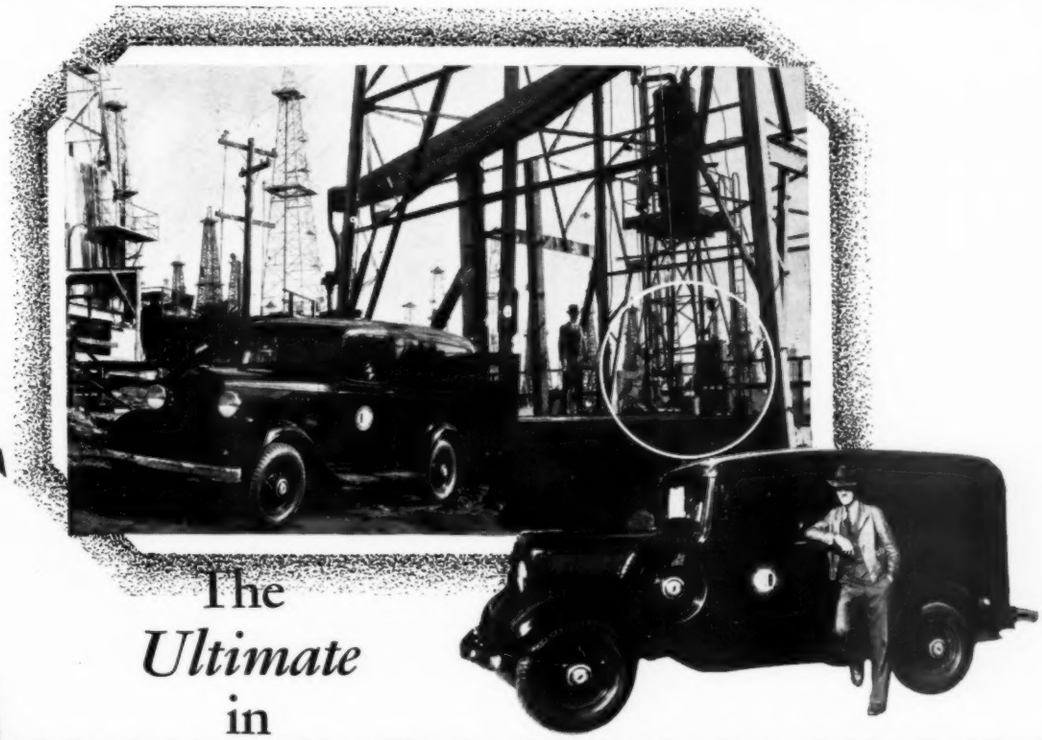

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California Making Elaborate Plans For A. P. I. Meeting

RESERVATIONS for hotel accommodations in Los Angeles during the period of the Sixteenth Annual Meeting of the American Petroleum Institute, which opens November 11th, have practically exhausted the available rooms in the Biltmore Hotel, official headquarters, and two near-by hotels report a full house, according to word from local committees in charge of arrangements in the California city.

The oil fraternity on the West Coast is preparing to take full advantage of this year's opportunity to play hosts to the petroleum industry. Special preparations are being made to handle transportation requirements with taxi stands established at all hotels housing visiting institute members and preferential rates for the convenience of delegates.

Other courtesies to be provided will include a complete information bureau with information on train schedules, airplane arrivals and departures, street car and taxi service, and plans for the most direct routes to all points of interest in the city and surrounding communities. Visiting members of the Institute are assured of convenient transportation arrangements.

The Institute session in Los Angeles will mark the opening of the most important gathering of this nature on the coast in several years and the most important event yet staged by the oil industry of the state. Both official and business leaders, headed by Governor Merriam, are uniting to assist the oil fraternity in welcoming its national leaders.

With more than 1000 reservations now in the hands of the committee on hotel accommodations, it is expected that more than 3500 members of the Institute will be in attendance from east of California.

Selection of Los Angeles for the meeting will provide an opportunity for engineers and operating officials to gather first hand information on existing conditions and methods of operation in California fields that may be profitably applied in other sections of the country. California operators in past years have pioneered numerous improvements in operating technique that have become standard practice in fields throughout the world.

Within the past two years development of directional drilling has been carried out at Huntington Beach and Long Beach fields and can be numbered among the more important recent developments. Some engineers feel this drilling innovation has been thoroughly developed, others are of the opinion its usefulness is but beginning to be recognized and that it eventually will be applied universally in scientific development of well-mapped structures. Had directional control been generally known in the early days of Long Beach, the "Old Timers" who prayed and begged for a chance to sink a well in the center of the old Signal Hill cemetery, in the heart of the most productive section of the field, would have been able to realize their dream and bottom their wells within a few feet of the exact center of the graveyard, drilling from a derrick location as much as four blocks away from its edge.

Other new developments of importance in California include the drilling of multiple wells from a single foundation that has been pioneered at Elwood field, where the ocean has been mastered in the fight for oil production. At Semi-Tropic the drilling of gas wells has been established on a manufacturing basis with one drilling outfit, rig and all, moved from location to location where the hole is drilled and prepared for production and the entire equipment moved on to the next location. An extensive study of bottom-hole pressures has been conducted at Kettleman Hills. New mechanical devices to be inspected will include hydraulic pumps, plunger lifts, multiple cylinder gas engines, and unitized drawworks. Central gauging and cleaning plants, waste water disposal systems, mud treating and other innovations, some of which are peculiar to California and some of which are in service elsewhere, will draw the attention of A.P.I. members.

A program of unusual interest is being prepared for the annual dinner to be held at the Biltmore Hotel, November 13th. The master of ceremonies will be a nationally-known figure and a stupendous show will be staged.

Plans call for an amusement program to run continuously throughout the dinner with a varied schedule of vaudeville headliners, screen stars, stage and radio personalities contributing.

In addition, a nationally-famous orchestra has been obtained to provide music for the occasion. A number of special stunts also are being prepared for the program, which will portray some of the more humorous sidelights of the industry, its leaders and outstanding personalities.

Aerial map of the Kettleman Hills in California. Many delegates to the A.P.I. meeting will inspect this interesting area. (Photo by Fairchild Aerial Surveys, Inc.)

Calculations for and Methods of Design of Slide Rule for Use in Oil Pipeline Problems

By

L. V. W. CLARK,* R. FALLAH,* and A. W. NASH*

THE mechanics of fluid flow can be divided into two sections, namely, hydrostatics and hydrodynamics. The former, which deals with fluids at rest, is governed by the well-known laws of physics and presents little interest here.

The section devoted to hydrodynamics has been dealt with by a number of investigators and numerous graphs and alignment charts have appeared in the literature for pipe line design, but practically all these either lack simplicity or are not general in character.

The physical characteristics of petroleum products differ from each other and from water with the result that the problems confronting those interested in pumping petroleum products cannot be solved by the formulae customarily used for hydraulic operations. Notwithstanding this fact, any fundamental formulae for determining the flow of viscous fluids must be based on hydrodynamical principles.

As a result of studies carried out by a number of investigators a general relation applicable to all fluids and conditions of flow was predicted and an explanation of the existence of two modes of flow, namely, streamline and turbulent, was provided after an investigation by Osborne Reynolds. The factors that governed the magnitude of the velocity at which the change from streamline to turbulent flow took place were explained by the application of dimensional similarity. An application of this principle to his results enabled Osborne Reynolds to calculate the critical velocity for flow in the two pipes under examination. When the ratio $\frac{vd\rho}{\mu}$ had a value about 2000 the critical velocity was reached and above a value of 3000 turbulent flow was established. Below 2000 the flow was streamline. Reynolds obtained sufficient evidence to permit the ratio $\frac{vd\rho}{\mu}$ to be accepted as a general criterion of similarity of motion. The value of the expression $\frac{vd\rho}{\mu}$ or $\frac{vd}{\nu}$ is now known as Reynolds' number or criterion.

The principle of similarity was further confirmed by Stanton and Pannell, who showed that the law of resistance was independent of the nature of the fluid or the size of the pipe. These investigators plotted the coefficient of resistance $\frac{F}{\rho v^2}$ against Reynolds' number $\frac{vd}{\nu}$ and since the function $\frac{F}{\rho v^2}$ has the same properties as the coefficient "f" in the well-known pipe flow formula $h = \frac{flv^2}{2gm}$ and is in fact equal to one-half the coefficient, by evaluating $\frac{vd}{\nu}$ and referring to a graph the correct value of "f" can be read, thus enabling the equation to be solved for all conditions.

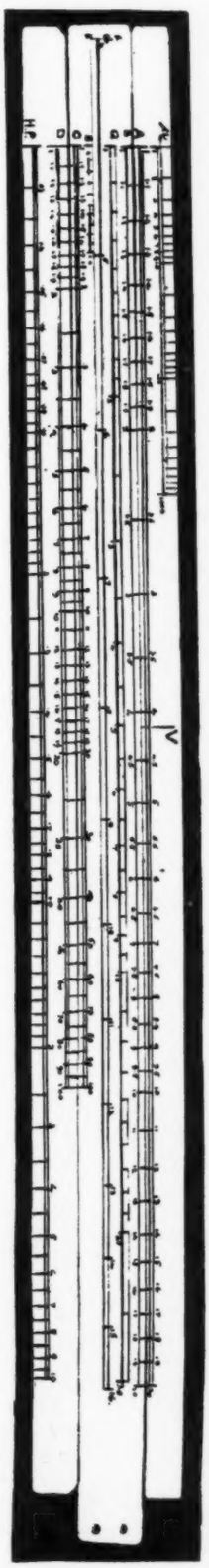


Fig. 1

The friction factor "f" for turbulent flow of fluids is a complicated function of $\frac{vd}{\nu}$, pipe diameter and roughness, and cannot be expressed as a simple function of these variables. For a limited range of $\frac{vd}{\nu}$ and pipe diameter, however, "f" can be expressed as a power function of $\frac{vd}{\nu}$ without incurring serious inaccuracies. It should, therefore, be possible to obtain such a formula, which applies fairly accurately to the ordinary oil pipeline practice and thus by substituting for "f" in terms of $\frac{vd}{\nu}$ in the flow formula a readily soluble equation is obtained.

It can be shown that for turbulent flow of fluids and any given diameter a gradual decrease of "f" occurs with an increase of rate of flow and that this variation can be represented by means of a sloping curve that assumes a law of the form $f = C\left(\frac{vd}{\nu}\right)^n$ in which the values of C and n are fixed to give the best equation for the curve. From the observations of Stanton and Pannell if n be taken as —0.25 then C must be taken as 0.08: this gives the relationship $f = 0.08\left(\frac{vd}{\nu}\right)^{-0.25}$

In the computations for determining a satisfactory formula from which to design the slide rule for pipeline problems three values for the friction factor "f" as suggested by various investigators were considered. The values were: $f = 0.08\left(\frac{vd}{\nu}\right)^{-0.25}$, $f = 0.09\left(\frac{vd}{\nu}\right)^{-0.25}$, and $f = 0.06\left(\frac{vd}{\nu}\right)^{-0.2}$. The value of "$f$" finally decided upon was $f = 0.085\left(\frac{vd}{\nu}\right)^{-0.25}$, since this agreed best with the actual available pipeline data and satisfied both experimental and practical results over the range most frequently used.

This value was, therefore, substituted in the

*Oil Engineering and Refining Department, University of Birmingham, England.

formula $h = \frac{4flv^2}{2gd}$ so that the formula now reads:

$$h = \frac{2 \times 0.085 \left(\frac{vd}{\nu}\right)^{-0.25} 1 \times v^2}{g\,d} \quad . \quad . \quad . \quad (1)$$

In order that the slide rule might be capable of being read in terms of every-day usage it was necessary to convert the factors h, l, v, g and d into general terms.

$$Then\ P = \frac{5.34\, s^{0.75}\ \mu^{0.25}\ Q^{1.75}\ l}{d^{4.75}} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

in which P = Pressure drop in lb. per sq. inch.

μ = Absolute viscosity in poises.

s = Density of the fluid in grams/cc.

Q = Quantity of oil pumped in bbl. per hour.

d = Diameter of pipe in inches.

l = Length of pipe in miles. (In this instance, $l = 1$ mile).

In formula (2) P is the pressure drop in lb. per sq. in. that the pumps must supply and the total pressure will be $P \times \frac{\pi d^2}{4}$. This total pressure multiplied by the velocity of the oil will be a measure of the Hydraulic Horsepower, i.e. H. hp. varies as $P \times Q$, and when all the terms are in the form required:

$$\text{H. hp.} = \frac{PQ}{2451}.$$

If the pump has an efficiency of e percent the brake horsepower necessary for the operation of the pump is:

$$\text{B. hp.} = \frac{\text{H. hp.}}{2451} = \frac{PQ}{2451 \times e\%} = \frac{0.00218 s^{0.75}\ \mu^{0.25}\ Q^{2.75}}{d^{4.75} \times e}$$

. . . . . (3)

A slide rule was designed incorporating Equations (2) and (3), the construction and operation of which is very simple and is, indeed, convenient for pipeline engineers. It enables the calculations of pressure-drop, horsepower, velocity and, in addition, can be used as an ordinary slide rule for multiplication, division, squares, square roots, cubes, cube roots, etc.

The manner in which the slide rule was designed is governed by nomography and in this instance the scales are all logarithmic.

Scales for C and D (Fig. 1) were chosen to obtain a convenient length for the slide rule and graduated from 1 to 100. These scales will be termed standard scale. The other scales μ, Q, s, d and $H.P.$ were graduated as follows:

Scale μ = ¼ standard scale graduated from 1to 1000.

Scale Q = 1¾ standard scale graduated from 1 to 30.

Scale s = ¾ standard scale graduated from 0.5 to 1.

Scale d = 4¾ standard scale graduated from 4.524 to 15 and extended backwards to 4.

Scale $H.P.$ = Standard scale graduated from 0.0245 to 10.

where μ = Absolute viscosity in centipoises.

Q = Rate of flow in bbl. per minute.

d = Diameter of pipe in inches.

s = Density in grams/cc.

D = Pressure drop per mile in lb./sq. in.

$H.P.$ = Horsepower per mile.

The scales as drawn above on a sheet of paper were cut in three positions, scales (μ, A) and (D, $H.P.$) representing the upper and lower fixed portions of the rule and scales (B, Q, d, s, and C) representing the middle or sliding portion.

The several parts of the calculating rule will be referred to as follows: the two parts firmly connected with each other are the "Rule", the part movable in the rule is the "Slide", and the sliding frame carrying a glass plate with a line across it is the "Cursor."

Simple calculations can be carried out as with an ordinary slide rule, with the aid of the scales A, B, C, and D in addition to the specialized ones of pressure drop, hydraulic horsepower, brake horsepower, and velocity.

Pressure Drop

Given, μ, s, Q, and D, the pressure drop can be read as follows:

1. Bring cursor line to viscosity read on scale μ.
2. Move the slide until starting line (BC) is on the cursor line.
3. Bring the cursor line to density read on scale s.
4. Move the slide until the starting line is again on the cursor line.
5. Bring the cursor line to flow rate read on scale Q.
6. Move the slide until diameter read on scale d is on the cursor line.
7. Bring the cursor line to the starting line of the slide.
8. Read pressure drop per mile against line on scale D.

If at the point (5) the value of Q is outside the rule divide the result by 10, i.e., in (4) move the slide until 10 on scale C is on the cursor line. The value of pressure drop thus obtained must be multiplied by 10.

Hydraulic Horsepower

1. Bring the cursor line to pressure drop read on scale D.
2. Move the slide until the starting line is on the cursor line.
3. Bring the cursor line to flow rate read on scale C.
4. Read Hydraulic Horsepower against the cursor line on scale $H.P.$

Brake Horsepower

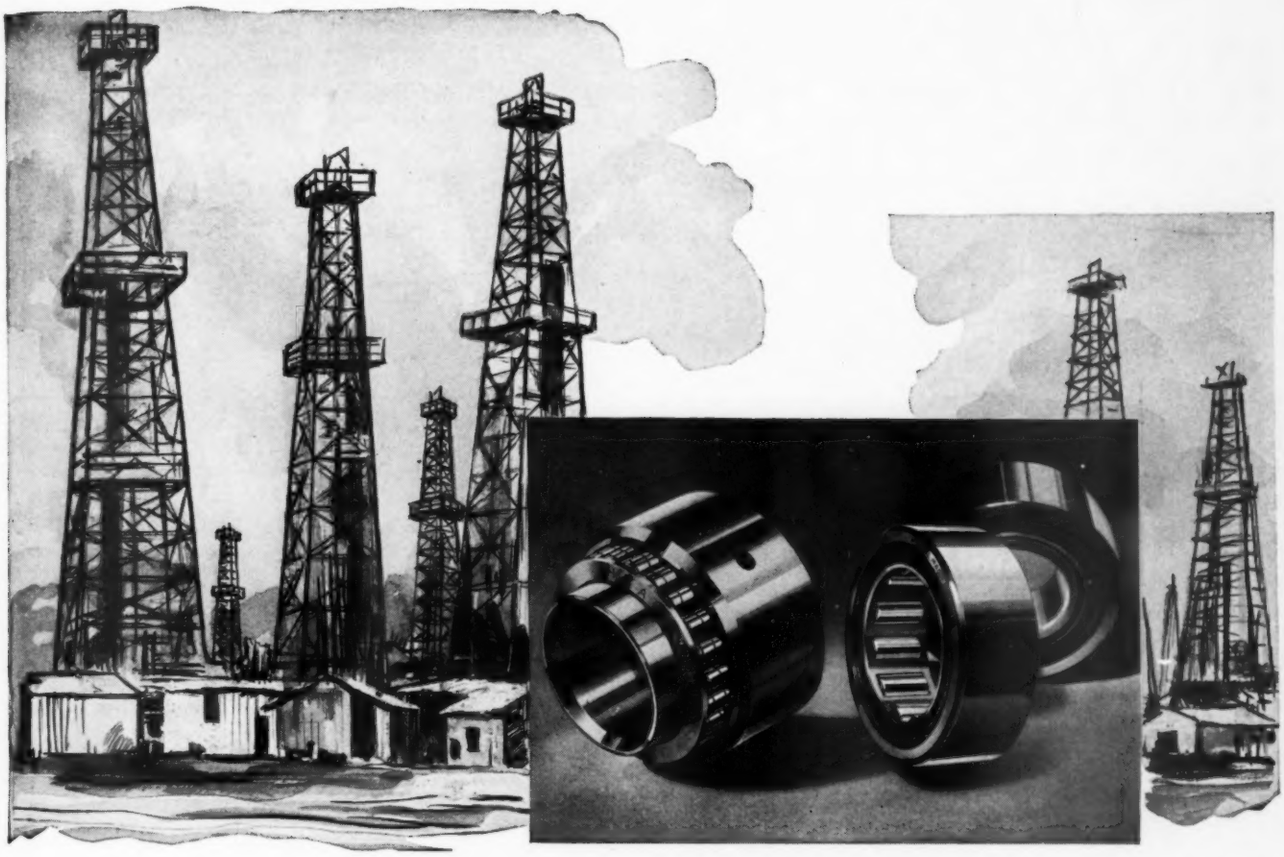
1. Bring the cursor line to H.H.P., read on scale $H.P.$
2. Move the slide until the efficiency percent, read on scale C is on the cursor line.
3. Bring the cursor line to 100 on scale C.
4. Read B.H.P. against the cursor line on scale $H.P.$

Velocity

1. Bring the cursor line to diameter, read on scale A.
2. Move the slide until the flow rate, read on scale C, is on the cursor line.
3. Bring the cursor line to vertical line V, on scale A.
4. Read the velocity in feet per second against the cursor line on scale C.

Similarly, from a knowledge of velocity and diameter, and velocity and flow rate, it is possible to calculate flow rate and diameter, respectively.

The reading of V on scale A is 4.14, i.e., the velocity of flow in ft./sec. through a 4.14-in. diameter tube is equal to the rate of flow in bbl. per minute.



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Resistance Pyrometer for Measuring Subsurface Temperatures

By W. C. LANE

MANY times the application of a little ingenuity and a well-known physical law will enable a field man to solve a troublesome problem. This is especially true when one is in some of the out-of-the-way places at which oil is found. The time element prevents one from appealing to manufacturers for assistance, for by the time they are ready to supply the required device the need for it has passed.

Some years ago while experimenting with bottom-hole electric well heaters for removing paraffin from the face of the oil sand the writer became weary of looking down the hole and speculating on the probable temperature at the bottom. Maximum thermometers and melting crystals had been inserted in a receptacle attached to the bottom of the pump barrel but these gave no information until after the test had been concluded and the tubing pulled. It was then too late to increase or decrease the amount of energy supplied to the heater in compliance with the apparent need for a higher or a lower temperature.

Unfortunately no two wells seemed to behave in the same manner and the temperature of the oil when it reached the surface gave no information, for it seemed to depend more on the weather than anything else. Doubtless this was due to the refrigerating action of the expanding gas rising in the annular space surrounding the tubing. Simple calculations will show that on a 30-bbl. well, 2500 ft. deep, equipped with 2-in. tubing and ⅝-in. rods, the oil spends about 6½ hours on its journey to the surface. Obviously the column of oil would have ample time to lose not only the external heat applied but also some of that which it possessed when it came into the reservoir from the formation.

It did not appear to be a difficult matter to improvise a resistance pyrometer to be run in on the tubing and thus make it possible to determine the temperature at any time during the test. However, oil field warehouses 50 miles out on the desert do not usually carry a large variety of the materials used in the manufacture of such devices. Fortunately the services of an exceptionally clever electrician were available and the final success of the proposed device was due largely to his skill and perseverence.

It was planned to utilize the well-known principle that the resistance of conductors composed of the ordinary metals increases with an increase in temperature; that for all practical purposes, within the temperature range involved in our test, this increase is a constant quantity. There are certain exceptions to this law but these need not be considered here. A coil was to be constructed and its resistance measured at known temperatures so that a curve showing the relation between the two quantities could be plotted. Means had to be provided for protecting this coil from fluids, gas, and mechanical injury and for connecting its terminals to a resistance measuring instrument located on the well floor.

A survey of the warehouse revealed a spool of No. 31 cotton-covered copper magnet wire, a stock of $1\frac{1}{16}$-in. brass condenser tubes and several rolls of No. 12 solid hard-drawn duplex rubber-covered copper wire. Fortunately we had a Wheatstone bridge for making resistance measurements and plenty of thermometers covering the desired temperature range. The electrician's first step was to filch a broom from the janitor and cut off about 18 in. of the handle for making a bobbin on which to wind the coil. This was chucked in a lathe, turned to the proper dimensions, given a coat of insulating compound and wound with about 1000 ft. of the No. 31 wire. The terminals of the coil were then attached to substantial leads that passed through holes drilled in one end of the bobbin. The whole assembly was then given a coat of insulating compound, covered with a layer of varnished cambric and allowed to dry. A cross section of the coil is shown in Fig. 1.

While waiting for the coil to dry, a section of brass tubing about 18 in. long was cut off and one end closed by brazing a disc of copper in it. The interior surface of the opposite end was threaded for about 1½ in. so that an improvised stuffing box could be screwed into it. The coil was then inserted in the tube, the extra space filled with transformer oil, the leads brought out through the stuffing box, and the device was ready to be calibrated. An outline of the assembled unit is shown in Fig. 2.

It was necessary to improvise a calorimeter and this was accomplished by taking a short piece of 4-in. pipe, threading and capping one end of it, insulating it with boiler lagging and mounting it in a vertical position on fire brick. The pipe was filled with transformer oil and heat from a blow torch applied through a hole cut on the lagging. The coil and a thermometer were suspended in the bath and the resistance measured at different temperatures by means of the bridge. From the data thus obtained a Resistance-Temperature curve was plotted. Obviously this curve will be a straight line so that only two readings need be made but it is well to take several in order to eliminate possible errors.

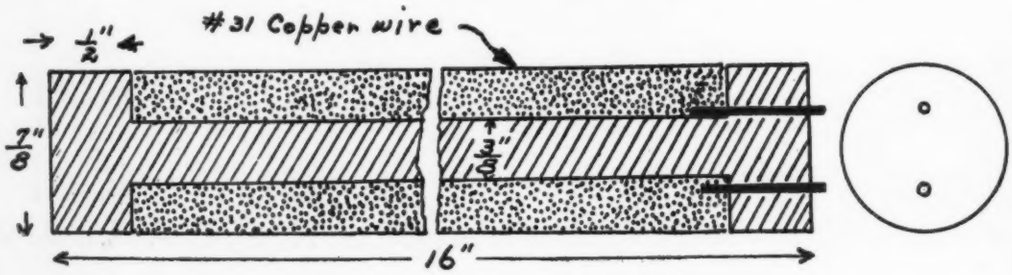

Fig. 1. Cross section of resistance coil used in construction of pyrometer

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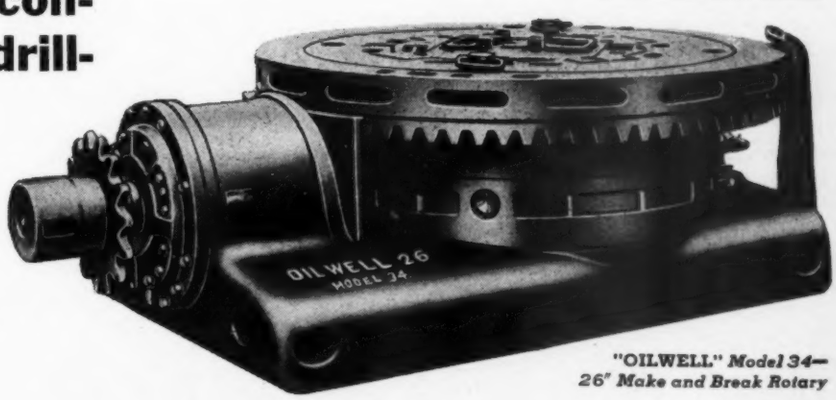

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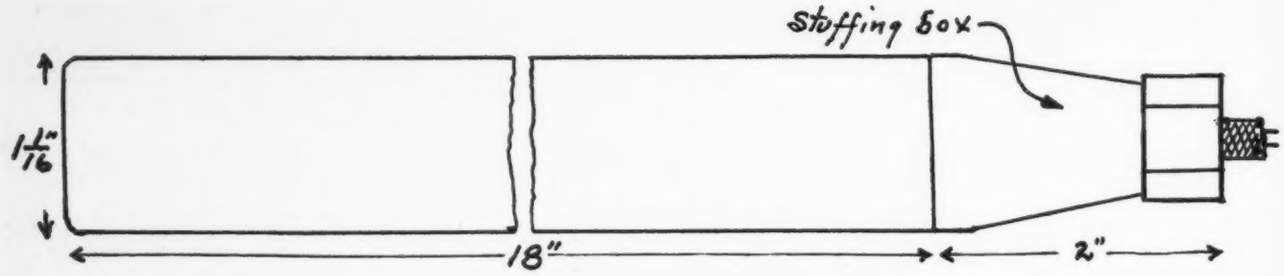


Fig. 2. External view of resistance pyrometer for measuring surface temperatures

In using the device on the heating test the tube was attached to the perforated pipe just below the pump barrel and leads were brought up along the outside of the tubing and supported at regular intervals by the clamps used to support the electric cable over which energy was supplied to the heater. A Wheatstone bridge of the post-office-box type, deckade form, a type that is direct reading, was used to measure the resistance. The chief difficulty encountered was due to cable trouble, for rubber-covered wire is not intended to be used in such a place. This may be eliminated by procuring an armored cable but, as was stated above, the time element of the work was such that we had to use material that was available.

Such a device was found to be very helpful and was used on numerous occasions for measuring subsurface temperatures. Among the applications may be mentioned the heating test above, the determination of formation temperatures, temperature of wells following shooting, thermit tests for removing paraffin, and the effect of heating the gas used in repressuring. On shallow wells where there is no high-pressure gas to complicate matters the operation of the device is very simple. The tube is light and when provided with a suitable sinker may be run in on the electric cable used for the leads. An ample spooling drum should be provided having a good brake, for hand-wound devices have a habit of getting out of control. "Believe it or not," on one test when the cable parted near the top of the casing at a time when the device was hanging at rest near the bottom of the hole, the line "ratted up" in the casing about 50 ft. from the top. The "rat's nest" was caught with a torpedo harpoon and the test continued after cutting out about 50 ft. of the cable.

Referring to the matter of cable for leads, ordinary No. 12 duplex hard-drawn copper wire was used unsupported on wells up to 2867 ft. deep. Since only the voltage produced by a dry cell is used on the bridge, a cable is good for several tests before the insulation gets too bad to use. The inaccuracy of the method due to the error in the leads does not appear to be as great as one might think. The resistance of the leads may be measured at a known temperature and corrections for change of resistance made for a given test; but the temperatures at points up and down the hole are rather indefinite. Since the resistance of the leads used was only five or six per cent of the total, the small errors made in the temperature corrections do not appear to affect the final results materially. To verify this, sets of blank leads connected together at the bottom were run parallel to the regular leads and simultaneous observations made. The difference in the results obtained was found to be of no importance.

On one occasion the device was used to determine the fate of a debatable practice,—that concerning the merit of heating the input gas used on repressuring work. Those versed in theoretical thermodynamics can demonstrate on paper that when gas at, say 560 lb. gauge pressure and 100 deg. fahr. temperature, is put down a well and it actually expands at the bottom of the tubing to a formation pressure of 100 lb. gauge, the resulant temperature will be 47 deg. below zero. Furthermore it can be shown mathematically that if the temperature of the input gas is raised to 300 deg. fahr. the resultant temperature will be about 100 deg. fahrenheit. Now if this actually happens perhaps some of the input wells that do not take gas readily are "frozen up" and the difficulty could be overcome by heating the gas. On one such well it was found that the hot gas used hardly got below the bottom of the "prairie-dog" holes. To be specific, the effect of heating the gas could not be detected below a point 100 ft. from the casinghead.

Data from which the curve shown in Fig. 3 was plotted were taken with the device. Heat had been applied to a pumping well for seven days, after which it was allowed to stand idle with the heat turned on for 24 hours. The heating was then discontinued and the temperatures observed while the well was pumped at its normal rate. It will be observed from the curve that it took seven days for the oil in the reservoir to regain its normal temperature of 98 deg. fahrenheit. During this period the well produced about 40 bbl. a day.

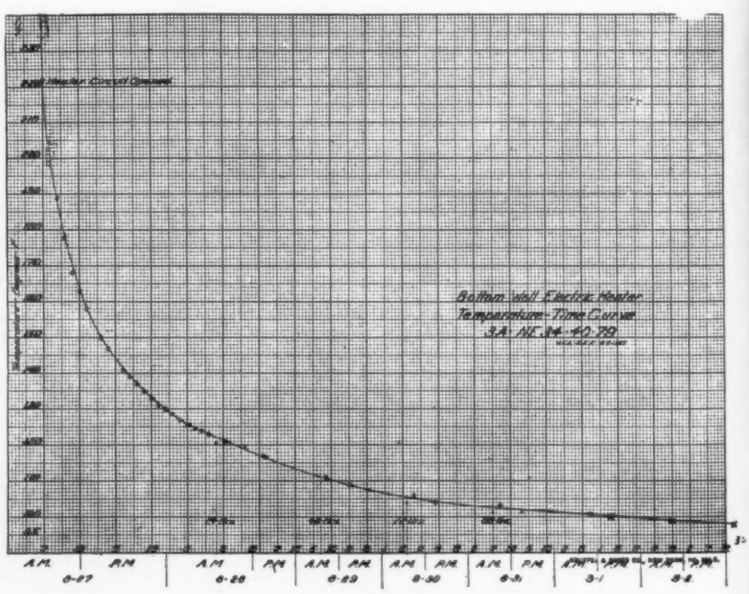


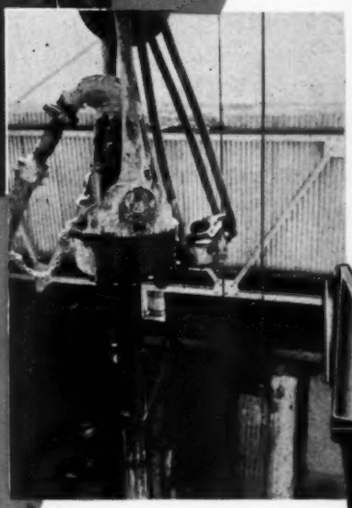
Fig. 3. Curve showing the persistence with which heat is retained by an oil sand after the region surrounding the reservoir of a well has been heated

EMSCO

TYPE "D" OIL COOLED ROTARY

SWIVEL

Emsco Type "D"
Oil Cooled Rotary Swivel



Emsco Type "CA"
300-Ton Swivel

The new Emsco Type "D" Oil Cooled Rotary Swivel with air cooled wash pipe stuffing box incorporates many new improvements in design that are destined to make this the longest wearing, most efficient and economical swivel ever offered oil field operators. A few of these major improvements are:

WASH PIPE: the design permits the wash pipe to rotate with the sleeve, assuring perfect alignment

WASH PIPE STUFFING BOX: air cooled; lubricated externally by grease gun; easily removed in order to change packing. The V-type packing remains stationary and is in direct contact with the wall of the stuffing box which is provided with cooling fins to assure dissipation of heat generated.

SLEEVE: designed to permit easy removal of the sleeve from the swivel without removing the coupling.

COUPLING: made with standard tool joint pin. A special rubber seal ring is inserted internally between coupling and sleeve to prevent leakage.

BEARING: main thrust bearing, S.K.F. barrel type, self-aligning, placed in lower part of swivel. American roller bearings placed in upper part of swivel carry the radial load.

Detailed Specifications Supplied on Request

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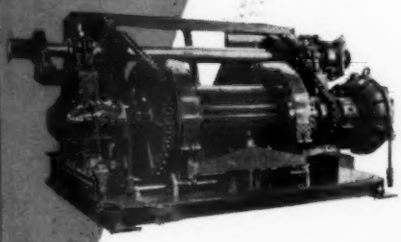
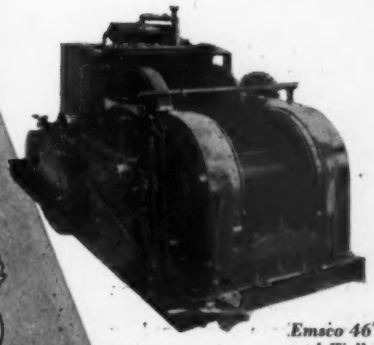
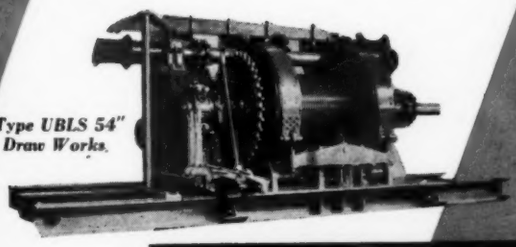


Emsco Type UH 54A
Unitary Draw Works

Emsco 76"
Traveling Block



Emsco 46" Portable Draw Works and Well Servicing Machine



Emsco Type UBLS 54"
Unitary Draw Works

EMSCO
A Complete Line of Better Oil Well Equipment

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Goodrich Rubber-Covered Gasoline Hose

A NEW rubber-covered, smooth-bore gasoline tank hose has recently been introduced by The B. F. Goodrich Company, Akron, Ohio, which, it is claimed by the manufacturers, increases volume of flow by 15 to 18 percent over the flexible metal-lined type.

It is available in two designs—with or without wire reinforcement. In all other respects construction is the same, consisting of a smooth bore tube, two braids of yarn of the hawser cord type, and a rubber cover. The best gasoline-resisting compounds are used throughout. Wire

reinforcement consists of a coil of wire laid between the two braids. Hose is furnished in any lengths up to 50 ft. in the following sizes: 1½-in., 2-in., 2½-in., and 3-inch.

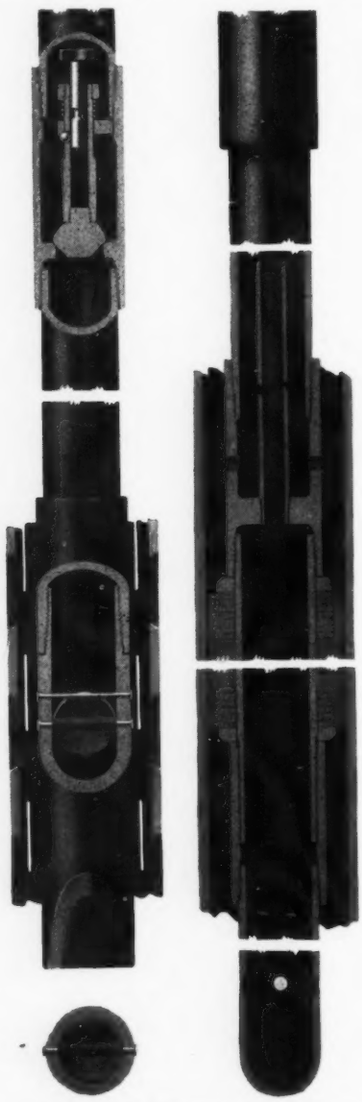
Static elimination or discharge is handled by means of a rustproof wire extending the length of the hose with a small spiral coiled spring inserted in the center to compensate for variations in length when hose is curved. On each end of the wire is a 6-in. length of light weight chain that is attached to the coupling by means of a bolt, giving direct metallic connection from coupling to coupling.

The manufacturer points out that, due to increased flow through this hose, truck unloading time can be reduced. Also because the cover is equally as gasoline-resistant as the tube, either type of hose—preferably the one without wire reinforcement—is adaptable to overhead tank car loading by the "under surface loading" method.

Johnston Screen Cleaners

A NEW method of cleaning well screen of sand and other sediment that block oil passage has been introduced by the J. L. Johnston Well Cleaning Service, 1530 Bonnie Brae Street, Houston, Texas. The method can be used on newly-completed flowing wells that become bridged over or sanded up, or on old pumpers that have become clogged, it is stated. The equipment is made in two types, both run on tubing and both employ the Johnston patented trip valve.

The outside cleaner employs use of a packer that runs through casing and is flush with the inside of the liner, to the point where the screen is to be cleaned.



JOHNSTON SCREEN CLEANERS

The tubing remains dry until the trip valve is released. When the valve is tripped the jet inside the cleaner forms a suction, creating a vacuum that pulls the fluid from around the tubing through the screen slots, cleaning them of sand and other sediment.

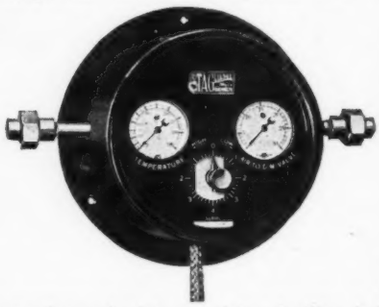
The inside screen cleaner functions by the manipulation of fluid in the hole, effecting certain hydrostatic pressures. Tripping of the Johnston valve, above the cleaner, causes an inrush of fluid from around the bottom of the tubing into the cleaner, which is dry until the valve is tripped. Fluid enters a butterfly valve within the cleaner until pressure of the fluid column is equalized all the way up the normal rise, then is trapped within the tubing. In the meantime the inrush of fluid within the screen has cleaned the string of "sluggish" sand or sediment that has impeded production.

The manufacturers claim for this method that it can clean screen in three hours after running to a given point that required several days under older methods.

TAG Number 40 Controller

A NEW instrument to be known as the TAG Number 40 Controller, said by the manufacturers to be ideally suited to the majority of automatic control applications, has been put on the market by the C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, New York.

The principle of control is basically the TAG movement that has served industry for many years. It has been redesigned for compactness in such a fashion that the few simple parts are accessible with exceptional ease. Tube systems can be



interchanged with surprising facility, it is stated.

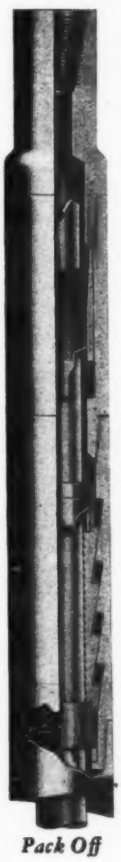
A novel spring lever designed to eliminate all lost motion multiplies the movement of the powerful capsular spring for sensitive yet positive control. The smallest change in temperature is transmitted positively and with great precision to the TAG Ball Air Valve that in turn resets the rate-of-flow through the diaphragm actuated control valve. In the TAG Number 40 Controller the sensitiveness is high and the accuracy is permanent, the makers state.

Indicating and non-indicating types in nine convenient temperature ranges and three pressure ranges are available in this new controller.

The company has prepared an interesting bulletin giving complete details of operation, specifications and prices, which they will send upon request.

WISE OPERATORS RELY UPON TESTED DEPENDABLE FISHING TOOLS

Shaffer Releasing Fishing Tools are noted for their successful operation under the severest conditions. Made of alloy steel scientifically heat treated and finish machined after heat treating these tools are as strong and durable as modern metals and methods can make them.



Pack Off

Socket

SHAFFER-HAMON ROTARY RELEASING SOCKET

A modern, strong dependable releasing tool for recovering drill pipe and tubing, either with or without rotary jars of any type.

SHAFFER-HAMON PACK OFF ROTARY RELEASING SOCKET

Where it is desired to force circulation through the fish we recommend the use of our Pack Off Attachment. The packing element is of flower pot type construction which seals off automatically by the fluid under pump pressure. The bowl carrying the packing element fits directly above the slips being easily disconnected when not required.

SHAFFER EXPANDING PIN TAP

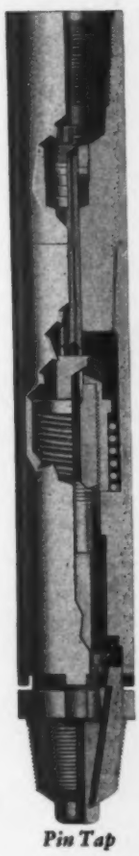
The only tool of its kind to catch tool joints or couplings. Run on left-hand pipe it is screwed into the tool joint box or coupling. By lifting up and turning to the left the slips tighten in the coupling or tool joint box so that all the force which the left-hand pipe is capable of may be used to unscrew the fish. If unable to unscrew fish the Pin Tap is easily released and withdrawn.

SHAFFER-HAMON ROTARY RELEASING SPEAR

Like the Releasing Socket this is a strong, dependable tool for recovering casing and liners either with or without rotary jars of any type.

For the purpose of forcing circulation through the fish a simple pack off attachment is recommended. It consists of a mandrel the top end of which is threaded into the lower end of the guide nut. A swab rubber is securely mounted on this mandrel in such a manner that the circulation pressure being forced with the fish automatically seals the packer. Our records show that in many cases this attachment has enabled fish to be recovered when other methods have failed.

Spear



Pin Tap

GULF COAST RENTAL STOCKS

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SHAFFER ★ TOOL ★ WORKS

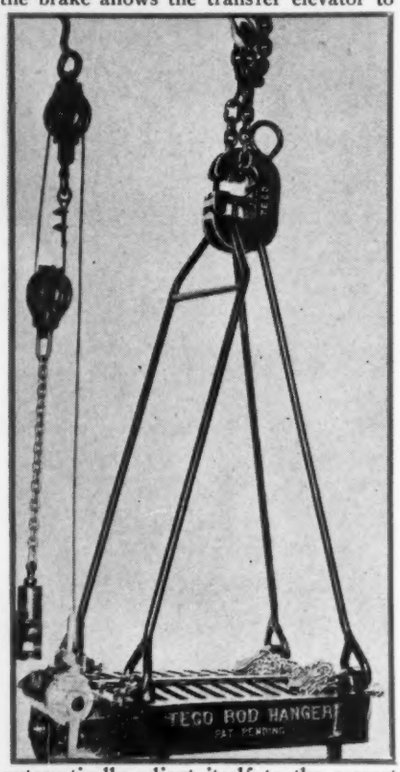
BREA·CALIFORNIA - HOUSTON·TEXAS - EXPORT - OIL WELL SUPPLY CO.

Teco Sucker Rod Hangers

THE Teco sucker rod hanger is an improved type of rod hanging apparatus, available in both portable and stationary types. The portable type is illustrated.

The Teco safety rack is of electric cast steel construction having a safety center guide tooth (pat. pending) between the two rows of supporting teeth that automatically locks the rack and acts as a guide when moving the rods in and out of the rack.

The Teco safety winch has an automatic over-load release brake (pat. pending) that allows fast and safe handling of the stands of rods. When pulling rods, the brake allows the transfer elevator to



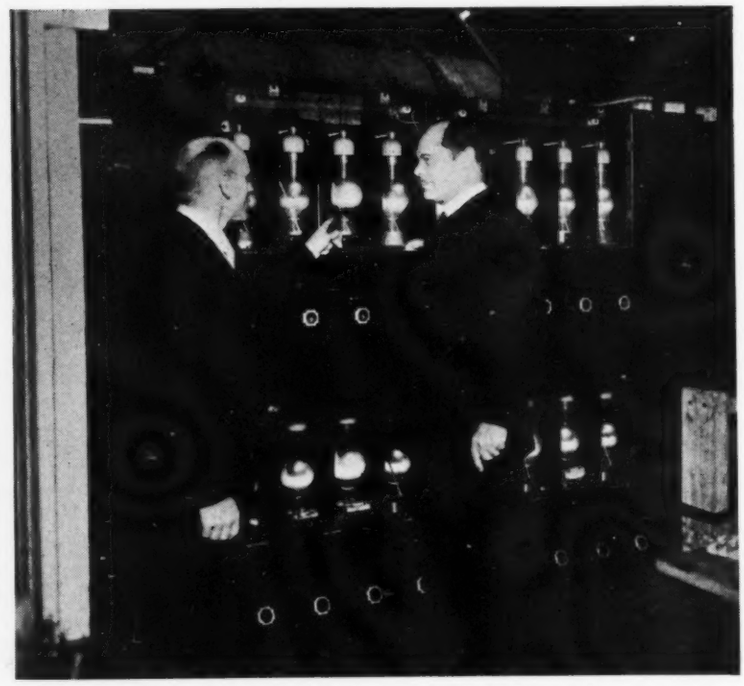
automatically adjust itself to the correct height for each stand of rods. When the brake is released the stand of rods may be lowered into the rack by its own weight without uncranking. A clutch arrangement prevents spinning of the winch crank when the crank is released. The Teco brake may be set to hold only one stand of rods, allowing the winch to unwind if the weight of the entire string of rods is accidentally applied to the transfer elevator due to failure to remove the elevator, preventing overturning of the rack.

The Teco safety transfer elevator, having an automatic locking device that closes when the elevator picks up a stand of rods and releases when the rod is set down, and a safety bail hook to prevent accidental dropping of a portable hanger when hoisting into the derrick, are other safety features of the rack.

The Teco winch has a rapid attachment device to allow quick and easy attachment and detachment from the rack, and may be applied to any rod hanger rack.

The Teco rod hanger is manufactured by The Engineering Company of Tulsa, Oklahoma, and is distributed through the Jarecki Manufacturing Company. Descriptive literature and complete information will be furnished upon request.

D-C Type Motor with Stationary Commutator Operates from A-C Source



A. H. Mittag (left) and Dr. E. F. W. Alexanderson (right), co-authors of A.I.E.E. paper on Thyratron Motor, electron-tube commutator of which is shown.

A NEW type electric motor, utilizing a "stationary commutator" and having the characteristics of a series-type d-c. machine but which operates from an a-c. power source, has been developed by E. F. W. Alexanderson, consulting engineer of the General Electric Company, Schenectady, New York. Known as a "Thyratron" motor, the new development is made possible by recent advances in the application of electron tubes. Announcement was made in a paper by Dr. Alexanderson and A. H. Mittag, also of the General Electric Company, which was discussed at the A.I.E.E. winter convention in New York City.

One motor of this type, already built, is rated 400 hp. at 625 r.p.m. and 75 hp. at 350 r.p.m. These are the specified ranges of hp. and speed for the particular application, although the motor may be successfully controlled down to standstill, if required. The equipment operates from a 2300-volt, three-phase, 60-cycle power supply.

Among the noteworthy features of this motor are the following:

(1) While running from alternating current, the motor has the characteristics of a series-type d-c. machine.
(2) The speed of the motor is independent of the frequency of the power supply.
(3) Smooth control of the speed can be obtained over the full range.
(4) In event of a momentary interruption of the supply circuit, the motor will, upon the restoration of power, start and return to the speed at which it was previously operating, without drawing excessive current from the line.
(5) The efficiency is high and the efficiency curve relatively flat—a distinct advantage, particularly in the lower portion of the speed range.

Because of these characteristics, motors of this type are applicable to such auxiliaries as fans, centrifugal pumps, compressors, and similar equipment having load characteristics such that the series type of motor can be used to advantage.

The motor has a stationary armature and a revolving field of the type used in synchronous motors. The armature, however, is provided with a special winding. Unidirectional current is supplied by means of a group of full-wave rectifiers that operate from the three-phase 60-cycle current source. The operation of the Thyratron rectifiers is controlled by means of grids in these tubes so that power is supplied to the motor windings in the proper sequence and amount necessary to give the required torque for operation. This control is obtained by means of a small distributor mounted on one end of the motor shaft. Speed control is obtained by varying the voltage supplied to the motor armature, by means of a phase-shifting device acting upon the same grids in the Thyratron tubes. Through this method, it is possible to obtain smooth speed control over the entire range for which the motor is designed.

The revolving field of the motor is connected in series with the neutrals of the armature windings and, as a result, the motor has the characteristics of the well-known series-type d-c. motor.

The Thyratron tubes, according to Dr. Alexanderson, perform two distinct functions, one being commutation and the other being grid-controlled rectification. Each of these functions has significance in the performance of the new motor. Through the commutator function, the smooth variable speed-torque characteristics of a d-c. motor are obtainable, without any reference to synchronism with the power source used. The grid-controlled rectifier function provides the motor with continuous power control from standstill to maximum speed, without wasting power in resistance.

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Unitized DRAWWORKS

AND UNITIZATION SERVICE

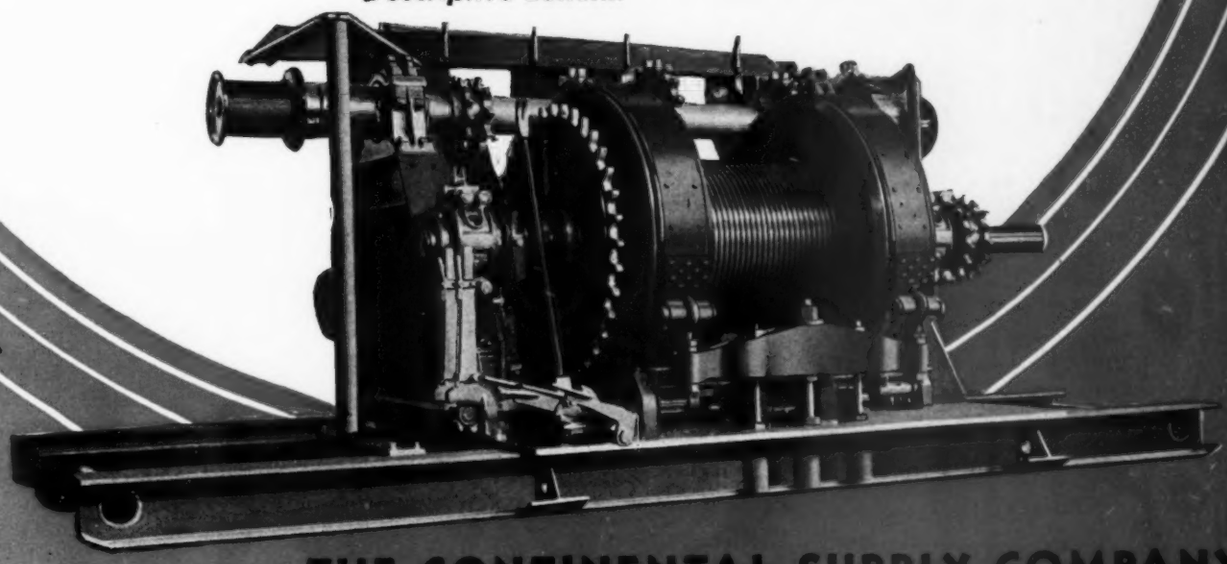
Emsco Unitized Drawworks are available with either long or short skids and various types of chain guards.

Unitization provides for greater strength and rigidity.

Ease and safety in transportation, installation and operation.

Eliminates derrick vibration and assures increased wear and efficiency of the brake.

For More Complete Information Ask For Descriptive Bulletin



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"Serving the Oil and Gas Industries"

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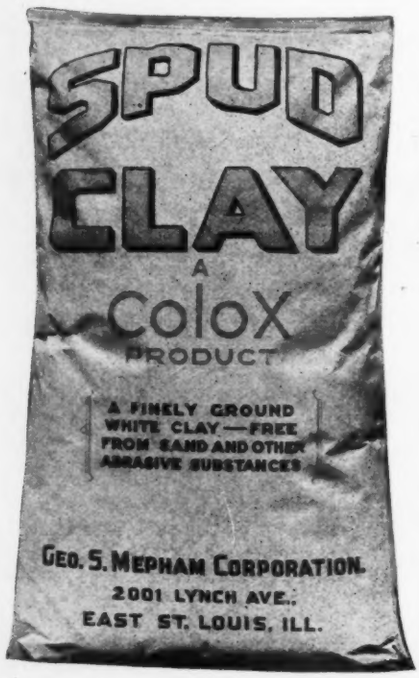
Spud Clay, a Product of Geo. S. Mepham Corp.

SPUD CLAY, a product of George S. Mepham Corporation, manufacturers of Colox, is on full production and being stocked throughout the active territories following thorough field tests.

This product, a natural clay of the Kaolin variety, is said by the manufacturer to be preëminently suited to the formation and control of drilling mud, particularly for spudding in and other work where weight is not required. It is a finely-ground white clay, free from sand and other abrasive substances, and acts as a good



lubricant in drilling mud. It is non-settling, and the manufacturers state that it serves as a good wall builder, and that it makes mud of good viscosity even at high concentrations.

An average analysis of Spud Clay, according to the makers, is:

Loss on ignition (combined moisture and carbon dioxide)	14.40%
Silica (SiO_2)	69.90%
Alumina (Al_2O_3)	12.40%
Magnesia (MgO)	1.85%
Calcium Oxide (CaO)	1.30%

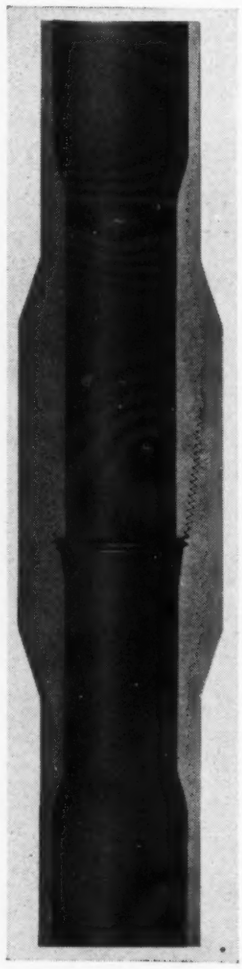
The above analysis describes the various elements usually reported in a chemical analysis. It does not describe the minerals occurring in the clay. Alumina and silica are combined to form an aluminum silicate, magnesia and calcium with carbon dioxide to form calcium and magnesium carbonates.

Spud Clay has a hydrogen ion concentration of pH of 4.5, indicating that it is slightly on the acid side, since an exactly natural material has a pH of 7.0. The slight acidity is derived from organic acids set free by the decomposition of organic matter. Spud Clay manufacturers explain that these traces of organic acids are neither strong enough nor active enough to corrode pumps or drilling equipment and do serve as an aid in drilling through sulphur water or salt formations.

The uses of Spud Clay are well outlined in a recently published paper, a copy of which is available through Colox Sales and Service, 2225 Arbor Street, Houston, Texas, or from Colox engineers in the field.

J&L Integral-Joint Drill Pipe

A NEW drill pipe of advanced design that eliminates the use of the conventional tool joint is announced by the Jones & Laughlin Steel Corporation of Pittsburgh, Pennsylvania. It is known as J&L Integral-Joint Blue Ribbon Seamless Drill Pipe, and is the latest addition to the J&L line of oil country tubular products, which includes regular A.P.I. drill pipe, casing and tubing, seamless and welded line pipe, and hot-rolled seamless steel boiler tubes.



The method of manufacture is as follows: First the end of the drill pipe is upset to a tool joint shape. After this upsetting operation, the drill pipe, not yet threaded, is heat-treated to produce the desired physical properties. Then a tool joint thread is cut on the upset end. This provides a tool joint integral with the pipe itself.

It is a fact now generally recognized that the threaded joints between drill pipe and tool joint are a frequent and dangerous source of twist-offs. The elimination of a large proportion of these threaded joints means fewer failures, and this in turn means lower cost and increased speed of drilling.

Another important feature of J&L Integral-Joint Drill Pipe is the smooth, easy change of diameter of the interior forming what might be called a "streamlined" interior, which reduces turbulence and gives increased mud velocity as compared with the standard tool joint with its sharp shoulders.

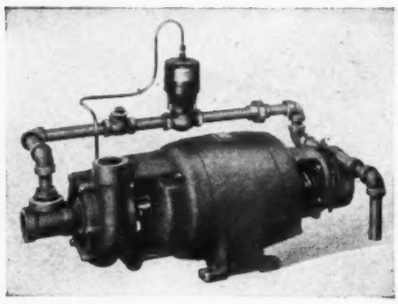
Box and pin threads of the J&L Integral Drill Pipe have both the hardness and wearing qualities of the best tool joint; there is sufficient stock in the upset of both box and pin ends for two complete rethreadings; and, since no heat treatment is required, this rethreading can be done by any shop equipped to cut a good thread, the manufacturers state.

The first string of J&L Integral-Joint Blue Ribbon Drill Pipe went into service over a year ago. Drill pipe of the J&L design is now in service in half a dozen fields. It already has drilled many thousands of feet of hole and has been subjected to all the requirements of field operation, it is stated.

Automatic Self-Priming Monobloc Centrifugal Pump

A DEPENDABLE pump that will unfailingly prime itself when necessary has long been sought for sumps, cellars, isolated water supply, and numerous industrial plant services.

Worthington engineers announce they have solved the problem through the use of the Worthington-built Hytor, a positive primer, placed on the same shaft with the motor and pump. The only



requirement is a reasonably tight suction line. When the pump—embodying the latest and most efficient impeller design—is primed, a pressure-operated cutout automatically unloads the Hytor. There is no re-circulation of water. There are no floats. Nor are there valves to set or give trouble. The priming apparatus has been exhaustively tested for 10,000 starts, equivalent to more than 30 years of operation, under most service conditions, it is stated.

The unit is compact and neat, modern in appearance, with a sturdy splash-proof stream-lined motor, all on a symmetrical mounting. There are no unsightly tanks or float chambers. The pump is available for single or polyphase 50- or 60-cycle a-c. as well as for d-c. operation.

Worthington Pump and Machinery Corporation, Harrison, New Jersey, will send on request a descriptive bulletin covering this equipment. Ask for W-323-B3.

Taylor "Valv-Precisor"

AS the demand for closer control of processing increases, engineers are constantly impressed with the fact that a diaphragm valve cannot always follow the dictates of the controller and therefore cannot produce the desired accuracy of control.

Many factors prevent correct positioning of the valve disks. A major one is hysteresis (friction and lost motion) of diaphragm motors, existent to a degree in all diaphragm motors, but to a greater extent in those of older design. Pressure fluctuations of the controlling medium through the diaphragm valve tend to force the disk of a single-seated valve out of its proper position. Other factors include friction in valve stuffing box due to worn packing or excessive tightening of adjustments, properties of controlling medium that may cause valve stem to pit or corrode or result in formation of salts, and worn parts in valve due to long service.

These factors affect the accuracy of control only to a small degree on high sensitivity applications (those involving small time lags) because only a slight deviation from the control point will increase or decrease the air pressure to the diaphragm

motor sufficiently fully to open or close the valve. But on applications involving reasonably large time lags the sensitivity of the controller must be adjusted to much lower values to produce throttling control. Consequently, when the valve-stem is opposed by the forces mentioned, considerable deviation from the control point will occur before the output of air pressure from the controller will be sufficient to move the valve disk. This causes an undesirable oscillating type of control.

Heretofore, according to the manufacturers, the only instrument that could precisely position a valve stem when opposed by these forces was the recently developed Taylor "Dubl-Response" Control Unit—an auxiliary control device designed primarily to accurately compensate for changes in load; precision-valve-action being an added feature to give double assurance of precision control. The precision-valve-action feature proved so vitally important, however, in solving this most difficult type of control problem that the Taylor Instrument Companies, Rochester, N. Y., decided to make this feature available in a separate instrument for those applications where load changes are not a problem but valve-stem friction and diaphragm-motor hysteresis must be overcome to obtain precision control.

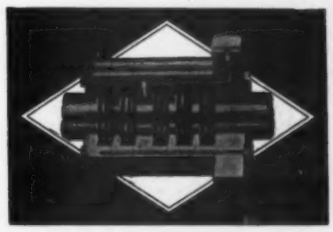
The manufacturer claims that, in general, any air-operated controller, with the aid of the "Valv-Precisor," can position the valve disk 50 times more accurately when opposed by valve-stem friction and diaphragm-motor hysteresis than when the device is not used.

This device is recommended by the manufacturer for all processes that have time lags or heat capacities demanding a low or medium controller sensitivity, provided that load changes are negligible or infrequent. It is unnecessary on processes with short time lags that permit a high controller sensitivity. It should not be used on processes involving large time lags and load changes. For such applications the company recommends the Taylor "Dubl-Response" control system.

The "Valv-Precisor" is a compact unit (case dimensions are 8 ft. x 5 ft. x 2 ft.) that can be mounted on any diaphragm valve, and can be used in conjunction with any air-operated controller. However, it must be so located on the diaphragm valve that a direct, rigid connection always is maintained with the valve stem. A 25-lb. per sq. in. air or gas supply is recommended for most efficient operation.

A non-corrosive case and cover protect the mechanism. The only necessary adjustment is to adapt the mechanism to the full travel of the valve stem. The air system is simple and essentially fool proof.

COOK'S METALLIC PACKINGS . .



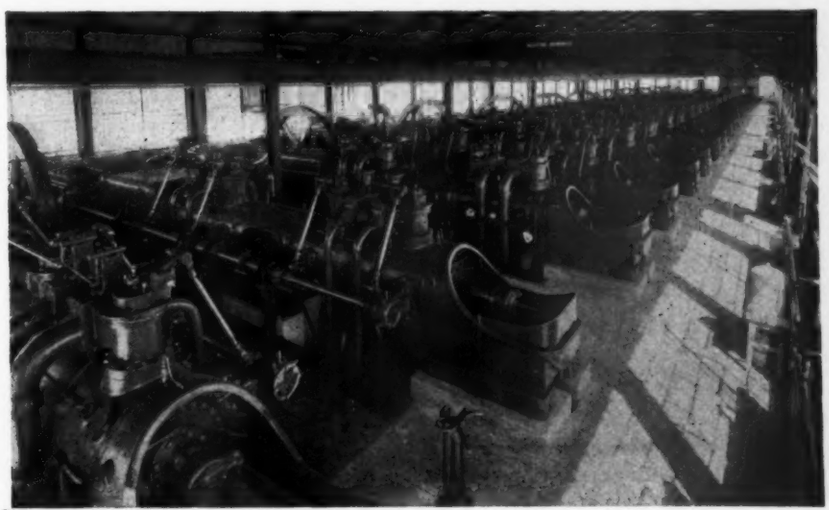


Photo courtesy of the Worthington P. & M. Corp.

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"Sealing Pressures Since 1888"

Wherever you may look throughout the oil and gas fields you will find COOK'S Metallic Packings predominate. A noteworthy installation is the 456 sets of COOK'S Power Packing and 114 sets of COOK'S 800-lb. Compressor Packing in the 57 Worthington Gas Engine Compressors serving the Chicago-Amarillo Natural Gas Line.

WRITE FOR INFORMATIVE LITERATURE

C. LEE COOK MANUFACTURING CO.

INCORPORATED

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Improved Pipe Wrench Has Cross-Locked Jaw

AN improved pipe wrench with features said to result in added years of useful service has been announced by the Walworth Company, 60 East 42nd Street, New York. A renewable lower jaw of hardened steel, with cross tongues seating into cross slots in the handle, is locked in place so as to eliminate backward shear on its pin and prevent loosening in service. However, the jaw can be easily renewed when required.

A new type of spring is said to have a much longer life and easier action. When necessary, it may be replaced without the use of tools. Other new features are said to include a comfortable hand-grip, larger capacity in the popular 10-in. size, reduced weight and narrower jaws in the 24-in. size, a Parkerized rust-proof finish, and a cadmium-plated nut.

The wrench is of drop-forged steel with its housing forged integral with the handle, heat treated for maximum strength. Complete specifications, sizes, etc., may be obtained from the manufacturer.

HERE'S THE ROAD

To
LOWER COSTS AND
GREATER ULTIMATE
RECOVERY!

THE experienced production man needs only a few minutes' study to understand why the "Fluid Packed Principle" means lower costs in his well . . .
— clearance of 20/1000 of an inch between the tubes insures slow wear
— no packing or cups are needed because fluid in these annular spaces serves as "fluid packing"
— efficiency is thus maintained after another 20/1000 inch wear has occurred
And, after all, "down time" — the expense of pulling jobs — lost production — the cost of replacement parts — are items which cannot be ignored by the operator who figures the "total cost per barrel pumped."

A PUMP that *remains in the well*, steadily *pumping week after week*, is the pump that insures maximum ultimate production. Why not write today for complete information as to the construction and operation of Fluid Packed Pumps?

See the Fluid Packed Pump Section in the 1935 Composite Catalog . . . or write our nearest office for complete information.

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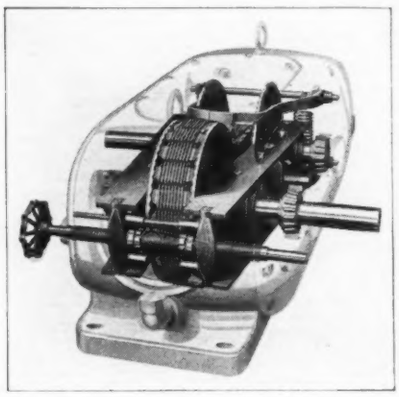
A MODERN PUMP FOR MODERN CONDITIONS
Protected by Patents No. 1545474, 1545475, 1549175, 1621046; others pending.

Motorized Variable Speed Transmission Announced by Link-Belt

ANNOUNCEMENT is made by Link-Belt Company, that in order to meet the growing demand for still greater range and flexibility of application, certain features of design recently have been incorporated in its P.I.V. Gear variable speed transmission that will permit the entire



line to be furnished in the following combinations and sizes:

(1) Motorized (when desired), with motor forming an integral part of the unit.
(2) With or without speed reduction gearing.
(3) With horizontal or vertical box.
(4) And in five sizes up to 15-hp. capacity.

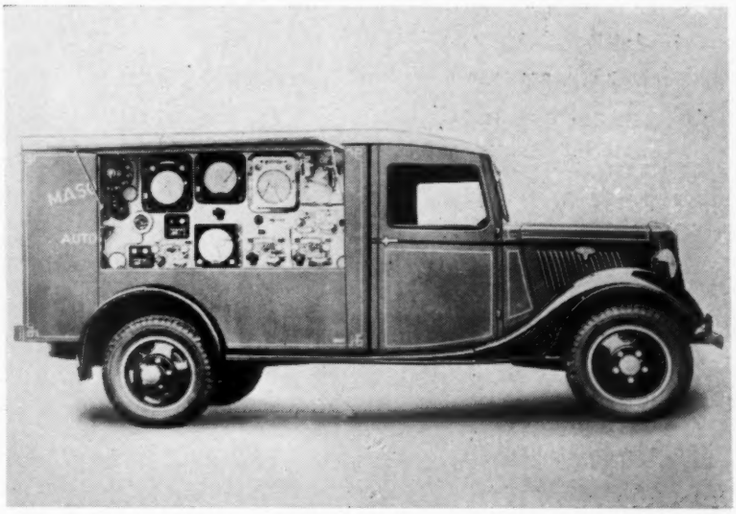
Previously, P.I.V.'s were available in sizes up to but 10-hp., with horizontal box only, and without reduction gear sets or the integral-motor feature. The motorized construction is said to make a very compact drive, eliminating the need of a separate motor base plate.

The operating principle of the basic unit remains the same as when introduced to American industry six years ago, at which time the unit was described as an innovation in variable speed transmission, and was the first all-metal, automatically-lubricated device that employed a specially designed side-contact chain operating between adjustable-diameter wheels with radially-cut teeth, for transmitting the power positively from input to output shaft.

A book, No. 1574, has been prepared to cover the new combinations and capacity range of P.I.V. Gears available, and will be sent to any interested reader upon request addressed to Link-Belt Company, 2045 West Hunting Park Avenue, Philadelphia, Pennsylvania, or the nearest office of the company.

Mason-Neilan Plans Field Demonstration

A NEW field demonstration service, believed to be the first of its kind and certain to be of outstanding value to large industries where instrumentation and control are major problems, was recently put into effect by the Mason-Neilan Regulator Company of Boston, Massachusetts. The new service unit, a specially designed truck, completely equipped with



up-to-the-minute reducing valves and control instruments, is making a nation-wide tour, giving demonstrations of modern control in important chemical plants, paper mills, refineries, process, and power plants.

This demonstration unit makes it possible for plant executives, process men, power plant engineers, and instrument men to bring themselves up-to-date on control. They can see, in a few minutes, what would otherwise require many miles of travel, and many days away from their plant. They can get first-hand information on the latest developments in temperature, pressure, and flow control. Control valve compensators that prevent overcontrol, overheat protectors, drift compensators, and frictionless duo-coil action are shown, all in operation.

The complete demonstration is under the supervision of a Mason-Neilan control engineer who discusses problems, answers questions, and gives ideas on cutting maintenance costs. The unit is offered as a free service, no matter where it goes.

The large number of requests for demonstrations that have been received assures the success of the venture, and has definitely established the truck as a permanent part of Mason-Neilan merchandising plans.

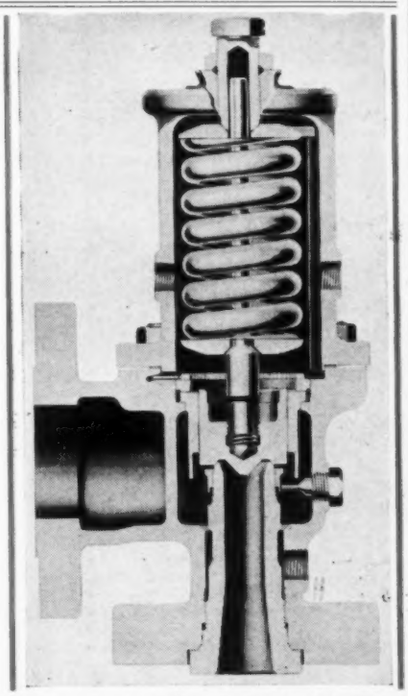
New York, Philadelphia, Pittsburgh, Toledo, Chicago, St. Louis, Tulsa, and Houston are some of the larger cities included on the itinerary.

Consolidated Oil Relief Valve

THE Consolidated Safety Valve Division of the Consolidated Ashcroft Hancock Company, Inc., Bridgeport, Connecticut, announces the "Consolidated Oil Relief Valve," having as its special features an outside bevel seat which, the manufacturers state, prevents any coking or pocketing of oil in the operating chamber, and a single blowdown ring that makes blowdown control simple and reliable.

The valve is designed for pressures up to 1000 lb. and temperatures to 900 deg. fahrenheit. All working parts are said to be non-corrosive, with the equipment containing no low melting point metals. The cover is easily removable, making the working parts accessible for inspection and cleaning. The springs are long with low fibre stress. As stated, the outside bevel seat of the bushing and the downflow surface of the disc prevent coking and pocketing of oil in the operating chamber, the discharge being diverted downward through an angle of 135 deg. and directed away from the seat.

Working parts are machined to tolerances of .001 in., making, the manufacturers point out, for maximum efficiency of operation in the field, and assuring easy replacement of parts without any change in operating characteristics. The reinforced, extended bushing eliminates



distortion strains, it is stated. These strains are absorbed in the annular rings so that the seat cannot be distorted by external installation forces.

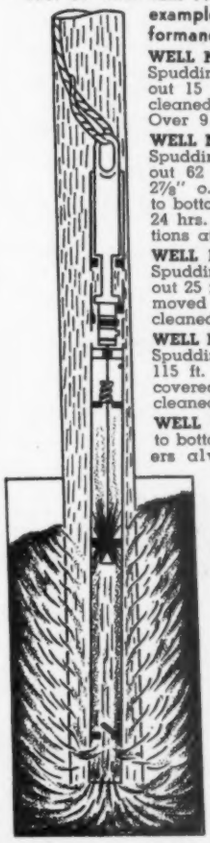
Spud Type Bailers are OBSOLETE for Cleaning Out

Use the

CAVINS

for Speed & Economy

The CAVINS ordinarily will have a well cleaned out in less time than it takes to rig up a string of tools or get other methods in operation. No spudding. No rigging up. It operates at high speed and recovers about 15 feet of sand in the tool on each run. Here are a few typical examples of CAVINS performance:



WELL NO. 1—(215 ft. of sand). Spudding type bailer cleaned out 15 ft. in 32 hrs. CAVINS cleaned out 200 ft. in 48 hrs. Over 9 times faster.

WELL NO. 6—(257 ft. of sand). Spudding type bailer cleaned out 62 ft. in 56 hrs. CAVINS 2⅞" o.d. Bailer cleaned well to bottom, recovering 195 ft. in 24 hrs. ALSO washed perforations at the same time.

WELL NO. 4—(60 ft. of sand). Spudding type bailer cleaned out 25 ft. in 16 hrs. CAVINS removed 35 ft. in 6 hrs., and cleaned well to bottom.

WELL NO. 8—(745 ft. of sand). Spudding type bailer recovered 115 ft. in 56 hrs. CAVINS recovered 630 ft. in 88 hrs., and cleaned well to bottom.

WELL NO. 2—(Never cleaned to bottom). Spudding type bailers always stopped 243 ft. from bottom. CAVINS cleaned out the bottom 243 ft., and production increased 40 barrels.

WELL NO. 10—(Bad pipe at 4,275 ft.) Spudding type bailers always stopped at that point. CAVINS cleaned out 119 ft. past bad pipe to bottom (4,394 feet.)

There are natural and scientific reasons why the CAVINS is the easiest, fastest, cheapest and best way to clean out your wells. Write for detailed information and performance records.

THE CAVINS COMPANY

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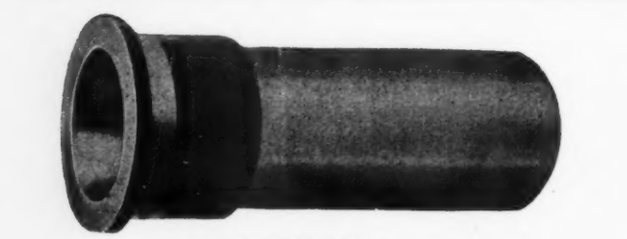
THE MAC CLATCHIE PUMP LINER
IS THE LONGEST WEARING LINER ON THE MARKET REGARDLESS OF PRICE

You can't judge quality by the high prices asked for some Pump Liners. MacClatchie "Money-Saver" Pump Liners are absolutely the highest quality and outwear brands that sell for two to three times as much money. Operators, large and small, are standardizing on this liner. Their long wear and LOW COST is responsible.

The MacClatchie "Money-Saver" Pump Liner is made of special alloy seamless tubing milled to our specifications and shipped to us in carload lots. This high grade alloy tubing gives the hardest and smoothest wearing surface and a uniformity of hardness throughout the entire surface of the liner. MacClatchie "Money-Saver" Pump Liners are quickly and economically replaced when worn. The detachable gland—which is subject to no wear and which therefore lasts indefinitely—slips onto the liner instead of being screwed onto it; and the gland co-operates with the integral collar of the liner for clamping the liner in the pump cylinder—a rubber packing ring being mounted on the liner to pack-off between the liner and cylinder wall.



Assembled Liner

GLAND
Which Slides on Liner and lasts indefinitely

LINER
Which is hardened alloy steel, ground to a mirror-like finish and economically replaced

PACKING RUBBER
Highest grade, economically replaced when necessary

MacClatchie "Money-Saver" Pump Liners are sold by leading Supply Houses.

Supply House: You are losing wonderful profits if you are not stocking and selling this long wearing liner of unsurpassed quality with its satisfactory commission to the dealer and low price to the operator.

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MANUFACTURING COMPANY
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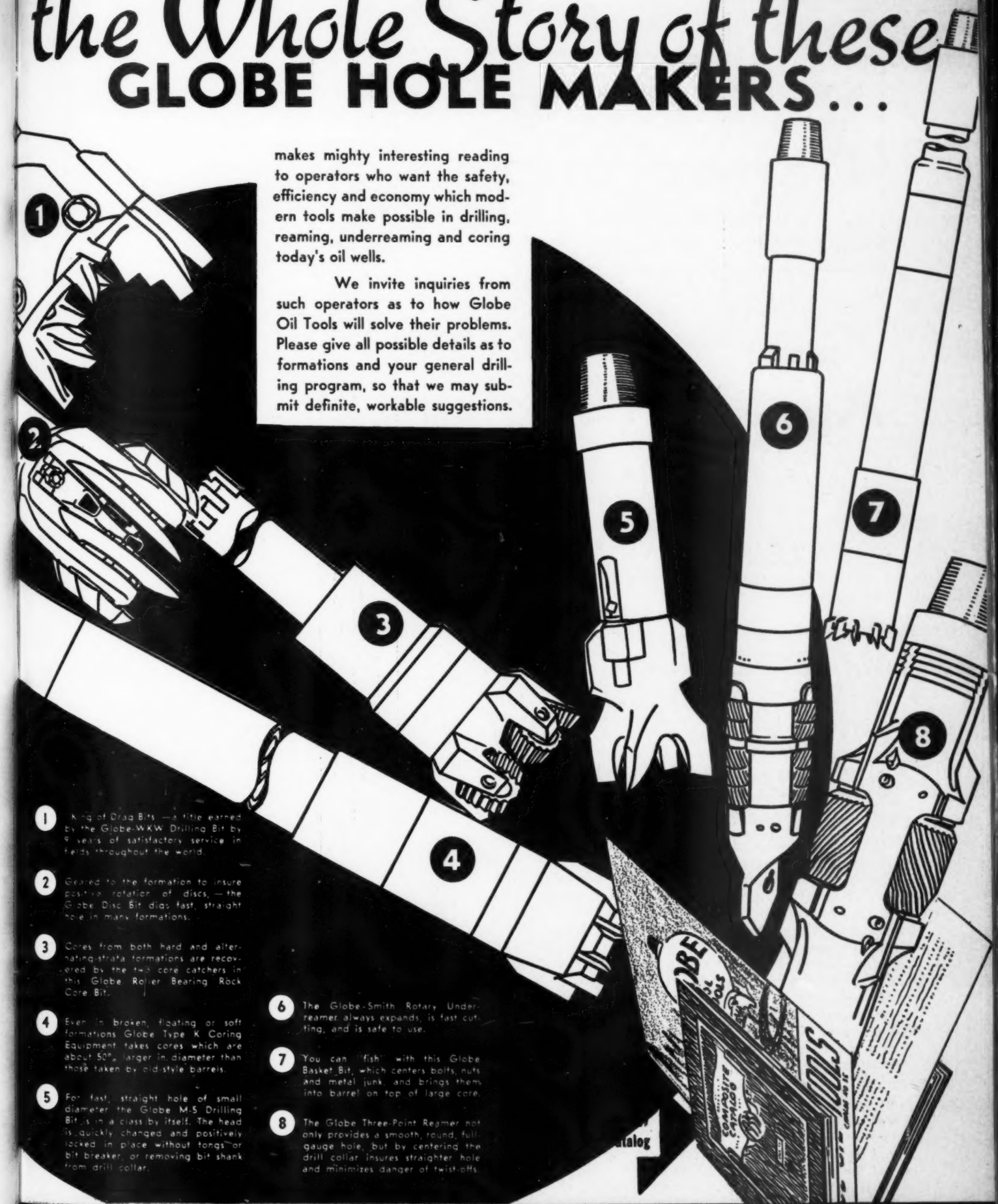
the Whole Story of these GLOBE HOLE MAKERS...

makes mighty interesting reading to operators who want the safety, efficiency and economy which modern tools make possible in drilling, reaming, underreaming and coring today's oil wells.

We invite inquiries from such operators as to how Globe Oil Tools will solve their problems. Please give all possible details as to formations and your general drilling program, so that we may submit definite, workable suggestions.



1. King of Drag Bits — a title earned by the Globe-W-K-W Drilling Bit by 9 years of satisfactory service in fields throughout the world.

2. Geared to the formation to insure positive rotation of discs, — the Globe Disc Bit dias fast, straight hole in many formations.

3. Cores from both hard and alternating-strata formations are recovered by the two core catchers in this Globe Roller Bearing Rock Core Bit.

4. Even in broken, floating or soft formations Globe Type K Coring Equipment takes cores which are about 50% larger in diameter than those taken by old-style barrels.

5. For fast, straight hole of small diameter the Globe M-S Drilling Bit is in a class by itself. The head is quickly changed and positively locked in place without tongs or bit breaker, or removing bit shank from drill collar.

6. The Globe-Smith Rotary Underreamer always expands, is fast cutting, and is safe to use.

7. You can "fish" with this Globe Basket Bit, which centers bolts, nuts and metal junk, and brings them into barrel on top of large core.

8. The Globe Three-Point Reamer not only provides a smooth, round, full-gauge hole, but by centering the drill collar insures straighter hole and minimizes danger of twist-offs.

GLOBE OIL TOOLS CO.

Engineering Fundamentals Department

- A Study Course for Field and Plant Men
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W. L. NELSON
K. C. SCLATER
Editors

Elements of Applied Petroleum Production

By K. C. SCLATER

Article 24

CLEANING-OUT AND REPAIRING WELLS—(Continued)

BESIDES the method of cleaning-out wells with heated oil already described, there are other means of using liquids for this purpose. Hydraulicking methods are used by means of which the face of the sand or the bottom of the hole is cleaned by the powerful action of a jet of liquid (water or oil). For the removal of loose sand, or even sand that has packed hard in the bottom of the hole, such methods are very effective, and besides, are quick and economical.

Hydraulicking methods for cleaning wells are the subject of an article[92], in which it is stated:

Hydraulicking Through the Pump

"The method of hydraulicking used depends primarily on whether or not a gas anchor is used on the pump. Where the wells are producing heavy oil with a minimum of gas, so that the gas anchor is not used, it is advantageous to hydraulic the well directly through the pump. The usual practice, particularly in wells not over 1500 ft. deep, is to pull the rods and tubing completely out of the well. The tubing is then lowered or raised to bring the bottom-collar to the top of the plug or highest bridge. The tubing is connected to floodlines and carrying fluid—for holding the solids in suspension—is pumped through the tubing. The action of the hydraulicking fluid is increased by the use of a nozzle, attached to the bottom of the pump. A swaged nipple * * * is commonly used for such a nozzle. * * *

"A method less frequently used, but one of particular use in deeper wells, is that of hydraulicking after the rods have been raised only enough to bring the standing valve clear of the pump. This saves the time required for pulling and replacing rods. In this practice one rod joint is removed and the polished rod and stuffing box are replaced. The rods are hung on a clamp placed above the stuffing box and the hydraulicking medium is introduced through the tubing-head while the tubing is supported in elevators.

Hydraulicking Where Gas Anchors Are Used

"Contrary to a misconception frequently met, hydraulicking is used in deep wells, is used in new territory, and is used in wells where the production of gas is such that the gas anchor is a necessary part of pumping equipment. Where the gas anchor is used the well cannot be hydraulicked without first removing the tubing from the well. After the gas anchor has been taken off, the tubing is run back into the well, either with or without the pump. Whether the pump is used or not, some sort of nozzle is usually provided to facilitate the hydraulicking action."

Well conditions may make it necessary to modify the method to be used.

"For hydraulicking very hard accumulations the use of a nozzle somewhat like a fishtail bit has been suggested. * * * The nozzle is made of double-extra-heavy tubing, drawn down to a chisel shape at one end, forming a nozzle with a long narrow orifice. An orifice with a width of about ¼-inch, and a length equal to the inside diameter of the tubing, gives good proportions. A feature to be noted in the nozzle * * * is the slight bell-mouth given the orifice at the end. This shape is for the purpose of permitting the easy ejection of sand which may become lodged in the orifice. The bell-mouthing is formed by swaging out the walls forming the orifice sides, after these have been flattened nearly into contact. The metal is heated only at the extreme end and a blunt chisel is used for the swaging. In using this nozzle a swivel is employed and the hydraulicking action is accompanied by a rotary drilling motion to assist in breaking up sand. By use of this tool an extremely hard plug of fine water-washed sand was cleaned out of a well at Santa Fe Springs field, California. The plug in this well was so resistant to the action of ordinary cable cleaning out tools that, as the driller expressed it, the 'tools just bounced off it.' The

well was cleaned out by hydraulicking with heavy oil, using the orifice described, at a rate of 20 ft. per eight-hour tour.

Removal of Sand After Hydraulicking

"The tubing is lowered into the accumulation at a rate depending on the hardness of the deposit, and the amount of hydraulicking fluid necessary to bring it into suspension.

"There are several ways in which the solids are got rid of after they have been brought into suspension. Sometimes an effort is made to circulate the solids out of the well, but this practice is not economical of carrying fluid and is almost entirely confined to application in new wells. The more common practice is that of bringing the rods and tubing into their initial position and pumping out the sand. In this procedure, it may be necessary first to raise the pump (to prevent its being sanded), and then to lower the pump as the sand is removed. When the bridge extends a considerable distance the pressure of the sand may 'squeeze' the fluid out of the mixture before all of it can be removed by the pump. In this case, simple flooding may be tried while pumping is carried on. If the flooding is not successful in this function, a second cycle of the hydraulicking operation may be necessary.

"If the mixture of sand cannot be successfully removed by pumping it may be practicable to pull the tubing and run the bailer or sand pump. Occasionally all of the sand attacked by the treatment will be carried out into the formations by the hydraulicking oil * * *." This was the case in one instance. "After hydraulicking no oil was removed by the pump and none heaved into the hole. This was probably due to the viscous hydraulicking oil being warmed and diluted with the lighter oil of the producing formations as the hydraulicking oil carried the suspended sand out into them. This resulted in a reduction of viscosity and the sand was dropped from suspension. The sand did not return to the well because the oil coming back to the well from the formations had neither sufficient viscosity nor velocity to lift or carry the solids.

" * * * The fundamental purpose of the hydraulicking method is the removal of sand from within the well. There is also action through the perforations similar to that of flooding and this action has probably been the cause of some unusual production increases which resulted where the hydraulicking method was used. * * * The method may properly be looked upon as one for the irregular removal of sand not removable by the flooding and circulation methods. * * * Hydraulicking has the advantage over cleaning out with tools of being cheaper, quicker, and reducing the danger to the oil string or liner incidental to pounding on hard sand at a collar of the pipe. * * *

"In hydraulicking, the capacity of the fluid to carry material in suspension is its most important feature. For this reason the vehicle should be clean and as viscous as may be conveniently obtained and used. Wells producing light oil are sometimes hydraulicked with a heavier oil. * * * "

"Viscous oil may be heated to advantage in getting oil to the nozzle, or to remove paraffine, but any heating of oil is always at the expense of the effectiveness in removing sand. * * *

"The only case observed where, to save oil, a fluid other than oil is used is in cleaning out a well near Newhall, California, producing a small quantity of very light oil. Water is considered of value as a carrying agent equal to the oil produced in the area and it is desirable that the well be hydraulicked with water to remove a fine-grained, water-washed sand which accumulates in the hole. Before hydraulicking, the well is allowed to stand idle for a couple of days to build up a head of oil for the purpose of preventing hydraulicking water entering the oil sands. Warm water is then pumped down the tubing and circulated up the casing until all sand is removed. The water is heated for the incidental purpose of removing accumulations of paraffin. Usually only ten bbl. of water is required.

"Emulsion, or emulsion in conjunction with oil, has occasionally been recommended by the writer as being better for the purpose of attacking water-washed sands than oil, but experiments have not been reported. For this purpose emulsion offers three advantages. First, it will 'cut' water-washed sands better than oil; second, it is more viscous, and hence a better carrier, than water; third, it will not 'wash' oil sands free of oil and replace the oil film about sand-particles with a water film. In hydraulicking a well with emulsion, sufficient emulsion should be introduced to bring the water-washed solids into suspension. The emulsion should then be followed with heavy oil, intended to rise in the hole as a 'plug' of viscous fluid following and under the emulsion-sand suspension. In this way the advantages of both emulsion and viscous oil would be made use of.

"Allowing the well to stand for a period prior to hydraulicking may save oil. Sufficient oil should be used to break up the sand, and to keep the solids in suspension until they can be removed. In wells producing heavy oil from half to two bbl. of oil are used per ft. of plug hydraulicked. This figure is obtained where the plug is not of water-washed sand. When hydraulicking such sand with oil a great amount is required. The rate to lower the nozzle into the compacted sand should be such as to allow for the complete mixing of sand, at the same time giving regard to minimizing consumption of oil and time. After the well has been hydraulicked it is important to take little time in getting the well on the beam or otherwise proceeding to remove the sand. The frequency of treatment must be determined as with any other cleaning-out operation—by observation of the well and its production rather than by any predetermined scheme. * * *

"In the 3000-ft. wells of a property in the Mid-way field, California, the average cleaning-out job requires three days with tools to go through an 80-ft. bridge, using four men while pulling and tubing the well, and two men while cleaning out. With hydraulicking, the same operation requires only eight hours with a four-man well-pulling gang.

"The worth of the method is further indicated by the fact that one operator uses it for redrilling oil strings in his wells, and accomplishes the job in as little as three days, where tools require up to thirty. Incidentally, the formations are left in better condition after hydraulicking with oil than they are after drilling with water. The sands are not water-washed, which sets up the resistance of surface tension; and this resistance must be broken down before the well may produce at a maximum. It is an important consideration that the gas pressure in depleted territory may not be sufficient to bring this about. This thought is equally important in considering the value of emulsion as a hydraulicking fluid."

QUESTIONS

1. How does the hydraulicking method differ from the method of cleaning with hot oil?
2. To what type of well is hydraulicking best adapted as a cleaning-out method?

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[92]"Hydraulicking Methods Used in Various fields for the Cleaning of Wells", by Lew Suverkrop. *Oil Field Engineering*, July, 1927.

[93]"Utilizing High Hydrostatic Pressure in a Well for Cleaning-Out," by Wallace A. Sawdon. *The Petroleum Engineer*, March, 1934.

[94]"Perforation Cleaner Designed to Revive Weak Wells." *The Petroleum Engineer*, January, 1933.

THIS *New* BAASH-ROSS SELF-ALIGNING SLIP DOES NOT BOTTLENECK THE DRILL PIPE

HOW THIS NEW SLIP WORKS

The upper cross-section view shows the full-bearing contact with the drill pipe of a Baash-Ross Self-Aligning Slip seated in a new master bushing.

Even when the master bushing is badly worn, as shown in the lower cross section, the slip liner is perfectly aligned with the vertical axis of the pipe. The slip liner is always free to rock within the slip body, thus presenting the full length of its face to the pipe with pressure evenly distributed against the drill pipe.

A NEW *Principle* THAT ASSURES FULL VALUE SLIP PERFORMANCE

Here is one of the liners from a Baash-Ross Self-Aligning Slip. Note the radius on the back of the liner. The interior of the slip body is machined to conform to this radius. Thus, while the liners are solidly backed up, they are also free to rock within the body and align themselves with the vertical axis of the drill pipe no matter how the slip body is seated in the master bushing.

The liners are knurled to provide the maximum holding ability and to release immediately when the pipe is raised.

Automatically COMPENSATES FOR WEAR OF THE MASTER BUSHING . . . *Always* Maintains Full Bearing on Pipe

Long examination of the wear on the teeth of ordinary slips and their marks on the drill pipe has shown that, even when new, the old type of slip rarely has an effective grip of more than four inches. As the taper of the master bushing changes through wear, the bearing of the slips on the pipe is reduced greatly, increasing bottlenecking and cutting the pipe.

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Elements of Applied Petroleum Refining

By W. L. NELSON
Consultant*

Article XXIV

FRACTIONATION—(Continued)

ABSORPTION AND STRIPPING

THE operations of absorption and stripping are in many respects similar to fractionation; however, in the case of fractionation the liquid and vapor are free to exchange places because as part of the vapor condenses on a plate it causes a corresponding evolution of vapor from the liquid on the plate, whereas in the case of absorption and stripping, the liquid and vapor do not vaporize or condense to any extent and only the component that we are interested in, is transferred from one phase to the other. As an example, in an absorption system for absorbing water from air by means of sulphuric acid, the air does not dissolve in the sulphuric acid, nor does the acid vaporize into the air, but the water vapor in the air is absorbed by the acid and the acid leaves the system containing the water that was originally present in the air. All three of the operations described, however, namely, fractionation, absorption, and stripping, involve the obtainment of equilibrium and may be practiced in a counter-current contact system such as a bubble-tower. Other equipments, particularly towers filled with a packing such as tile, may be used but in the petroleum industry the bubble-tower is used almost exclusively. As in the case of fractionation, the computation of the number of plates is relatively simple if only one or two components[1, 2] are to be absorbed or stripped, but if several components are present the computations become very involved and in the case of high-boiling petroleum oils the number of plates that are required cannot be accurately computed.

Inasmuch as the absorption of natural gasoline from wet refinery gases and the stripping of the gasoline from the absorption oil are the most important absorption and stripping operations in the refinery, the discussion will be confined to these two operations. A more complete background can be obtained by referring to texts on chemical engineering.[1, 2]

The handling of natural or refinery gas to produce natural gasoline, is indicated in Fig. 15, Article VI, April, 1934. Although natural gas and natural gasoline are not simple materials, there are methods by which they can be analyzed to find the percentage of each compound that is contained in them.

Absorption and Stripping Equations

The relation between the number of plates, the amount of absorption oil, and the properties of the oil and gas, was first put into a mathematical form by Kremser[3] in about 1930, and since that time improvements in the form of the equation have been made by Brown.[4] Although derivations of the absorption and stripping equations would be useful, they are too long to be presented herein. The fundamental equation of absorption as presented by Brown[4] is:

$$\text{Absorption, } \frac{y_{n+1}-y_1}{y_{n+1}-y_0} = \frac{A^{n+1}-A}{A^{n+1}-1} \quad \text{. . Eq. (1)}$$

in which:

n = number of equilibrium plates counting from the top.
y_{n+1} = composition of *incoming* gas-mol fraction.
y_1 = composition of *outgoing* gas-mol fraction.
y_0 = composition of gas in equilibrium with incoming oil (usually y_0 may be considered as zero)-mol fraction.
A = absorption factor—see discussion that follows.
$(y_{n+1}-y_1)$ = actual change in composition of gas.
$(y_{n+1}-y_0)$ = for practical purposes this factor may be considered as the change in composition of the gas if all the desirable components were removed.

Thus, the first factor of the equation, that is: $\left(\frac{y_{n+1}-y_1}{y_{n+1}-y_0}\right)$ for practical purposes is equal to the fractional reduction in the amount of the desirable component in the gas during the absorption operation, or if it is multiplied by 100 it represents the percentage reduction of the component in the gas. In applying the equation, if you wish to absorb 95 percent of a component, say pentane, from a gas, then the factor $\left(\frac{y_{n+1}-y_1}{y_{n+1}-y_0}\right)$ is equal to 0.95 and likewise

$$\frac{A^{n+1}-A}{A^{n+1}-1} = 0.95.$$

The other part of the equation, that is, $\left(\frac{A^{n+1}-A}{A^{n+1}-1}\right)$ is complicated by the exponents $(n+1)$ but it can be handled easily by means of a graph or tabulation of the equation;

TABLE 37

Value of A	Value of $\frac{y_{n+1}-y_1}{y_{n+1}-y_0}$ or of $\frac{x_e-x_n}{x_e-x_{n+1}}$ for the following number of equilibrium plates				
	Infinite plates	16 plates	12 plates	8 plates	3 plates
0.0	00	00	00	00	00
.2	20	20	20	20	20
.4	40	40	40	40	38
.6	60	60	60	60	54
.8	80	80	80	77	66
.9	90	89	87	84	70.5
1.0	100	94	92	89	74.5
1.1	....	96.6	95.5	92.3	78
1.2	....	98.5	97.7	95	81
1.3	....	99.6	99	96.5	83
1.5	....	....	....	98.5	87
2.0	....	....	....	....	93

*Professor of Petroleum Refining—University of Tulsa.

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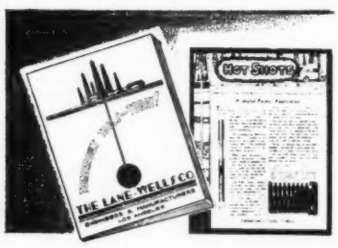

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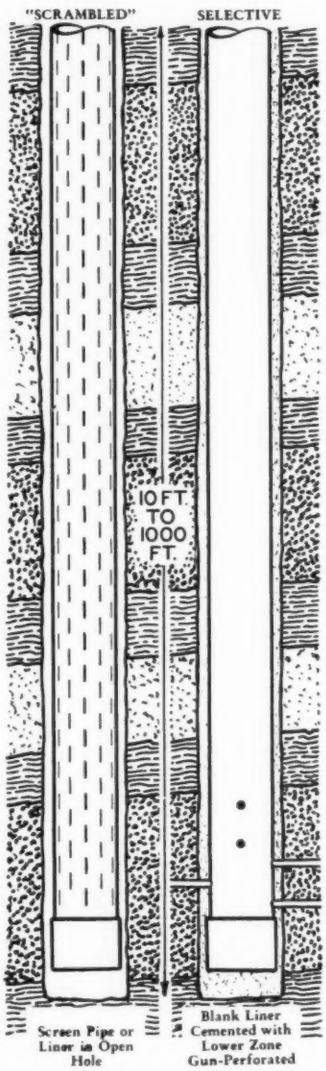
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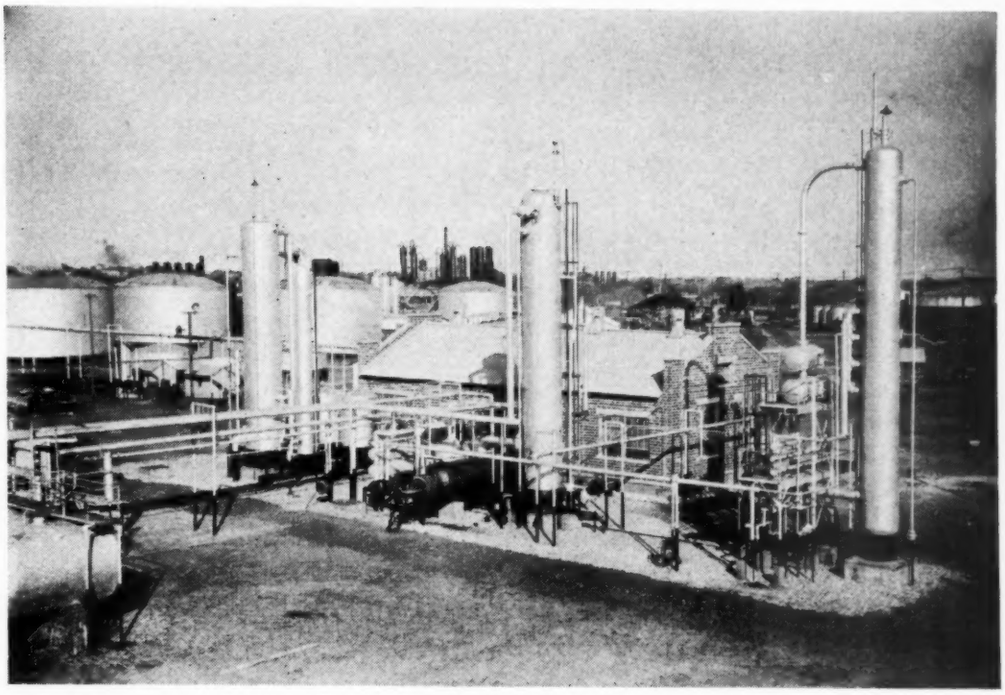

Fig. 48. Vapor recovery plant. (Courtesy of Arthur G. McKee & Co. and Petroleum Engineering, Inc.)

that is, by plotting A (the Absorption Factor) against the percentage absorbed. A tabulation of A, and of S (the Stripping Factor), against the percentage absorbed is given in Table 37 when using 3, 8, 12, 16, and an infinite number of plates.

Thus, if you desire to absorb 99 percent of a component in a 12-equilibrium or theoretical plate column, an absorption factor of 1.3 will be necessary. This applies to any component, say propane, iso-butane, etc., that may be considered. The relation of the Absorption and Stripping Factors to the properties of the oil and the component being absorbed or stripped, is discussed in a later paragraph.

The fundamental stripping equation[4] is as follows:

$$\text{Stripping, } \frac{x_e - x_n}{x_e - x_{n+1}} = \frac{S^{n+1} - S}{S^{n+1} - 1} \quad \ldots\ldots \text{Eq. (2)}$$

in which:

n = number of equilibrium plates.

x_e = mol fraction of component in liquid *entering* stripper (rich).

x_n = mol fraction of component in liquid *leaving* stripper (lean).

The factor $\left(\frac{x_e - x_n}{x_e - x_{n+1}}\right)$ refers to the fractional reduction of a component in the stripper. Table 37 may also be used to determine the relation between the fractional reduction and the Stripping Factor.

ABSORPTION AND STRIPPING FACTOR. These factors (A and S) are related to the amount of oil that is recirculated (or steam used to strip), to the physical properties of the component being handled, and to the properties of the absorption oil, thus:

$$A = \frac{3.156\,d\,G}{KM} \text{ or } \frac{3.156\,d\,G\,\pi}{PM} \quad \ldots\ldots \text{Eq. (3)}$$

in which:

d = specific gravity of absorption oil.

G = gal. of absorption oil per 1,000 cu. ft. of gas.

K = equilibrium constant for component.

M = molecular weight of absorption oil.

Or if Raoult's Law is valid for the absorber conditions:

P = vapor pressure of component—lb. per sq. in. abs.

π = total pressure in absorber—lb. per sq. in. abs.

Likewise the stripping factor:

$$S = \frac{1}{A} = \frac{K\,W\,M}{150\,d} \text{ or } \frac{P\,W\,M}{150\,d\,\pi} \quad \ldots\ldots \text{Eq. (4)}$$

in which:

W = lb. of steam required per gal. of oil.

*Refer to Table 16, Article XVI, February, 1935.

APPLICATION OF EQUATIONS. In determining the oil to gas ratio for an absorber it is common practice to decide how much of a particular component it is economically feasible to absorb from the gas. The value of A is then determined by Table 37, and the amount of oil circulation (or G) is computed from Equation (3). The other components will also be absorbed to varying extents, depending on their vapor pressures or equilibrium constants. An examination of Equation (3) shows that the only factors that change when a new component is considered, are the vapor-pressure and the Absorption Factor. The Absorption Factors for the other components are inversely proportional to the vapor-pressures of the components, thus:

$$A_1 : A_2 : A_3 = \frac{1}{P_1} : \frac{1}{P_2} : \frac{1}{P_3} \quad \ldots\ldots \text{Eq. (5)}$$

in which the subscripts 1, 2, 3, etc., refer to the several components. For the temperatures ordinarily encountered in low-pressure absorbers, the relation between the vapor pressures and Absorption Factors is almost a constant. For these conditions the following approximations may be used:[8]

Component	Absorption Factor
C_3H_8	.25 of the factor for butane.
iC_4H_{10}	.67 of the factor for butane.
C_4H_{10}	1.0 of the factor for butane.
iC_5H_{12}	2.67 of the factor for butane.

The actual use of the above formulations can be best illustrated by means of the example that follows.

EXAMPLE 37. *Absorption of Natural Gasoline.*

A gas has the following analysis:

	Volume Percent	Vapor-Pressure 80°F.* Lb. per sq. in. absolute
Methane, CH_4, etc.	86.	
Propane, C_3H_8	7.	141
Iso-Butane, iC_4H_{10}	1.3	60 (estimated)
Butane, C_4H_{10}	2.5	37
Iso-Pentane, iC_5H_{12}	1.2	15 (estimated)
Pentane plus, C_5H_{12} plus	2.	8 (approx.)

The absorber consists of 16 actual plates or about eight equilibrium plates and it operates at a temperature of 80 deg. fahr., and at a pressure of 50 lb. per sq. in. absolute.

The absorption oil is completely stripped of iC_5H_{12} and it has a specific gravity of .83 and a molecular weight of 160.

If 98.5 percent of the iC_5H_{12} is to be recovered, how much absorption oil should be used and how much of each of the other components will be absorbed?

To absorb 98.5 percent of the Iso-Pentane an Absorption Factor of 1.5 will be necessary. (Refer to Table 37).

$$\text{Oil Circulation or } G = \frac{1.5\,P\,M}{3.15\,G\,d\,\pi} \quad \text{(Refer to Eq. 3)}$$

$$= \frac{1.5 \times 15 \times 160}{3.156 \times .83 \times 50} = 27.5 \text{ gal. per thousand.}$$

The same amount of oil will absorb the other components as follows (refer to Eq. 5):

$$A \text{ for Propane} = 1.5 \times \frac{.25}{2.67} = .14 \left(\text{or } 1.5 \times \frac{15}{41} \right)$$

$$A \text{ for Iso-Butane} = 1.5 \times \frac{.67}{2.67} = .376$$

$$A \text{ for Butane} = 1.5 \times \frac{1.}{2.67} = .562$$

$$A \text{ for Pentane Plus} = 1.5 \times \frac{15}{8} = 2.8. \text{ (Refer to A for Propane).}$$

The amount of each component that will be absorbed can then be read from Table 37:

Propane Absorbed = 14 percent of the Propane in original gas.

Iso-Butane Absorbed = 37.6 percent of the Iso-Butane in original gas.

Butane Absorbed = 52 percent of the Butane in original gas.

Iso-Pentane Absorbed = 98.5 percent of the Iso-Butane in original gas.

Pentane Plus Absorbed = 100 percent of the Pentane Plus in original gas.

If we consider 100 cu. ft. of wet gas, the number of cu. ft. of each of the components that will be absorbed from the gas by the oil and the gaseous percentage analysis of the absorbed gases, will be:

		Cu. ft.	*Analysis*
Propane	= .14 × 7	= .98	16.5 percent
Iso-Butane	= .376 × 1.3	= .49	8.2 percent
Butane	= .52 × 2.5	= 1.3	21.85 percent
Iso-Pentane	= .985 × 1.2	= 1.18	19.8 percent
Pentane plus	= 1.0 × 2.0	= 2.00	33.65 percent

In addition, a small amount of methane, ethane, and air will be absorbed.

This material would be classed as a raw or wild gasoline and it would have to be fractionated to obtain a stable natural gasoline. The loss during fractionation would range from 20 to 45 percent, depending upon the properties that are desired in the finished gasoline.

QUESTIONS

1. From Equation (3), how would doubling the absolute pressure affect the amount of absorption oil required?
   Ans. Cut it approximately in half.
2. If the Absorption Factor for butane is 1.0, what will be the approximate value of the factor for iso-butane?
   Ans. About 0.67.
3. Following Question 2, what percentage of the butane in the gas, and the iso-butane in the gas, will be absorbed in a 16-plate absorber?
   Ans. Iso-pentane, about 67 percent; Butane, about 94 percent.

REFERENCES

[1]Badger & McCabe—"Elements of Chemical Engineering," McGraw-Hill Book Company.
[2]Walker, Lewis & McAdams—"Principles of Chemical Engineering," McGraw-Hill Book Company.
[3]*National Petroleum News*, p. 43, May 21, 1930.
[4]Souders and Brown, *Ind. Eng. Chem.*, 24: 519, 1932.

Bureau of Mines Analyzes Oil from New Wyoming Well

The crude petroleum being produced from the William Kyle No. 1 well in the Big Medicine Bow field, Carbon County, Wyoming, is an extremely light paraffin-base oil, according to an analysis of a sample recently completed by the Bureau of Mines, Department of the Interior. The crude oil is virtually free of sulphur and contains a large proportion of gasoline and kerosene distillate. The lubricating distillate fractions are very small in volume and contain wax as indicated by the cloud test.

Great interest was aroused by the news of the completion of this well, as it is considered to be the most important "wildcat" development in recent years in the Rocky Mountain area. The well was drilled in Section 26, T. 21 N., R. 79 W., to the second bench of the Sundance sand on the Medicine Bow structure, as a joint undertaking by the Ohio Oil Company and the California Company. The initial rate of production was 6,360 bbl. of oil per day, and the well had a potential production of 81,000,000 cu. ft. of wet gas through the Bradenhead from the first bench of the Sundance sand, which could be produced independently of the production of crude oil from the second bench.

Aside from the importance of the large flow of low-sulphur crude oil with a high gasoline and kerosene content, and the large potential production of wet natural gas, the well is significant because it marks a possible substantial increase in "green" or light-oil production in the Rocky Mountain area, which has decreased markedly in Wyoming and Montana in recent years.

The approximate summary of the analysis of this crude oil is as follows:

APPROXIMATE SUMMARY

	Per Cent	Sp.gr.	°A.P.I.	Viscosity
Light gasoline	38.1	0.669	80.0	.....
Total gasoline and naphtha	73.5	.710	67.8	.....
Kerosene distillate	11.7	.810	43.2	.....
Gas oil	4.1	.840	37.0	.....
Nonviscous lubricating distillate	2.2	0.844-0.865	36.2-32.1	50-100
Medium lubricating distillate	1.0	.865- .881	32.1-29.1	100-200
Viscous lubricating distillate	....	.....	.....	Above 200
Residuum	1.0	.931	20.5	.....
Distillation loss	6.5	.....	.....	.....

The detailed analysis of this crude oil is given below:

GENERAL CHARACTERISTICS

Specific gravity, 0.726 — A.P.I. gravity, 63.4°
Per cent sulphur, less than 0.10 — Pour point, below 5 deg. fahr.
Saybolt Universal viscosity at 77 deg. fahr., less than 32 seconds — Color, N.P.A. No. 3
Saybolt Universal viscosity at 100 deg. fahr., less than 32 seconds

DISTILLATION, BUREAU OF MINES HEMPEL METHOD

Dry distillation — Barometer 744 mm. — First drop: 30°C. (86°F.)

Temperature °C.	Per cent Cut	Sum per cent	Sp. gr. of Cut	°A.P.I. of Cut	Vis. at 100°F.	Cl'd test °F.	Temperature °F.
Up to 50	14.3	14.3	0.645	87.9	.....	.....	Up to 122
50- 75	10.9	25.2	.662	82.2	.....	.....	122-167
75-100	12.9	38.1	.701	70.4	.....	.....	167-212
100-125	12.8	50.9	.732	61.8	.....	.....	212-257
125-150	9.8	60.7	.753	56.4	.....	.....	257-302
150-175	7.4	68.1	.769	52.5	.....	.....	302-347
175-200	5.4	73.5	.783	49.2	.....	.....	347-392
200-225	4.3	77.8	.797	46.0	.....	.....	392-437
225-250	3.8	81.6	.810	43.2	.....	.....	437-482
250-275	3.6	85.2	.824	40.2	.....	.....	482-527
Vacuum distillation at 40 mm.—							
Up to 200	2.3	2.3	.837	37.6	40	15	Up to 392
200-225	2.1	4.4	.840	37.0	45	35	392-437
225-250	1.2	5.6	.850	35.0	56	55	437-482
250-275	0.8	6.4	.861	32.8	75	75	482-527
275-300	0.9	7.3	.874	30.4	145	90	527-572

Carbon residue of residuum, 4.5 per cent.
Carbon residue of crude, nil per cent.

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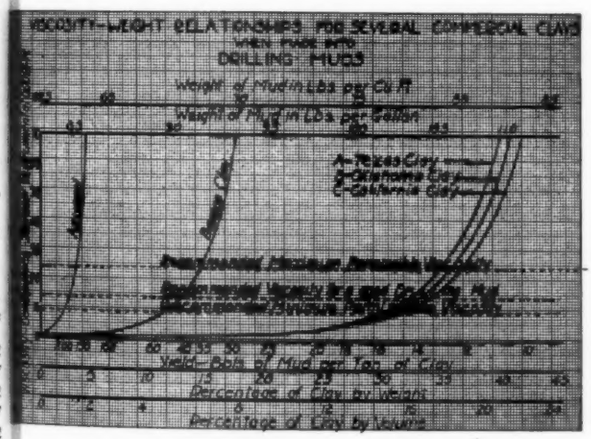
BAROCO, since it contains a higher percentage of gel-forming colloidal matter than *any* other commercial or native clay available for drilling mud, will build a *better* wall and will build it *more quickly* than other clays with a consequent proportional reduction in drilling difficulties.

In addition to its economy and superior wall-building properties, BAROCO clay is specially selected and processed to resist the "flocculating" action of salt and salt waters. Practically all native clays available for making up drilling muds are "flocculated" or "curdled" when they come in contact with salt or concentrated salt water during drilling, with a resultant separation of free water from the mud. Mud made from BAROCO is substantially unaffected by contact with salt or salt waters, and satisfactory drilling muds can even be made by mixing BAROCO directly with salt water. When mixed with salt water, the number of barrels per ton is slightly decreased.

The use of BAROCO is especially recommended for drilling on salt domes or where it is expected that salt water will be encountered.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Weight of Mud in Lbs per Gallon
A-Texas Clay
B-Oklahoma Clay
C-California Clay
Yield-Barrels of Mud per Ton of Clay
Percentage of Clay by Volume
Percentage of Clay by Volume

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Elements of Applied Petroleum Pipe Line Transportation

By C. E. MAIN, Sr.
Engineer, Sinclair-Prairie Pipe Line Co.

Article 15

FLOW OF LIQUIDS IN PIPE LINES (Part IV)

Application of Formulae

IN the articles appearing in the July, August, and September, 1935, issues of *The Petroleum Engineer*, the derivations of both the Hagen and the Chezy formulae were given together with several other useful formulae, applicable in parallel line flow computations, and a logarithmic graph (see pp. 82-83, August issue) of the Chezy friction factor curves that have been most frequently quoted in the hydraulic literature. This graph also gives several Temperature-Viscosity curves of gasoline, water, and crude oil.

Frequent reference will be made to these articles in the demonstration of the application of the several formulae in pipe flow computations that will now be considered.

Application of the Chezy Formula

A typical layout for a trunk line system of parallel lines may be shown diagramatically as in Fig. 2. We have in the first section, eight 8-in. lines; the second section, three 8-in. lines and two 12-in. lines; and the third section, one 8-in. line and three 12-in. lines.

The figures at the top of the sketch (Fig. 2) are the elevations of the hydraulic grade line and those at the bottom are the elevations of the pipe or the pressure gauges at the points shown.

Pump head = 1797 ft.; available friction head = 1657 ft.
Viscosity = 98.5 SUS at 35 deg. fahr., $K = 0.1944$, $B = 6150$.
Obs. Gravity = 38.0 deg. A.P.I. at 35 deg. fahr., Equiv. Dia. $D = 12.00$.

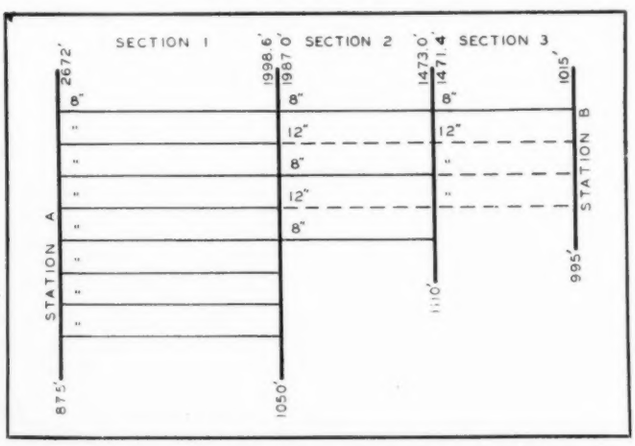

Fig. 2. Diagram of a Typical Layout for a Trunk Line System of Parallel Lines

L	= 15.00	14.00	15.00
N	= 2.6444	2.99165	3.33055
M	= 2.1450	1.5643	1.3523
B/DKN	= 996.90	881.20	791.60
$f\mu$	= 0.02602	0.02684	0.02757
b	= 683.4	514.0	456.4

Equivalent Number of Lines of a Given Diameter

When a station district of parallel lines has more than one size of pipe in any of the sections, it is necessary to determine the equivalent number of a given diameter that has the same carrying capacity as the pipes in each section of the station district. In this demonstration the 12-in. pipe size (49.562 lb. per ft.) is selected as the given diameter.

The first step is to compute by Equation 10 the equivalent number of 12-in. lines in an 8-in. line. The values of the exponents x, n, and w to be used in Equation 10, and which must also be used in Equation 11, will be taken as $x=1.25$, $n=1.75$, and $w=0.25$. We may now write Equation 10 as:

$$N = \left(\frac{7.981}{12.00}\right)^{\frac{2n+x}{n}} = \left(\frac{7.981}{12.00}\right)^{\frac{19}{7}}$$

$$= 0.33055 \text{ line 12-in. dia.}$$

Then for each of the three sections, we find by multiplying the number of lines of each size by its equivalent of 12-in. the equivalent number of 12-in. lines in each section.

SECTION 1:
Eight lines 8-in. dia. $= 8 \times 0.33055 = 2.6444$ lines 12-in. dia.

SECTION 2:
Three lines 8-in. dia. $= 3 \times 0.33055 = 0.99165$ lines 12-in. dia.
Two lines 12-in. dia. $= 2 \times 1.0 = 2.00$ lines 12-in. dia.
Total of 2.99165 lines 12-in. dia.

SECTION 3:
One line 8-in. dia $= 1 \times 0.33055 = 0.33055$ lines 12-in. dia.
Three lines 12-in. dia. $= 3 \times 1.00 = 3.00$ lines 12-in. dia.
Total of 3.33055 lines 12-in. dia.

The three equivalent number of 12-in. lines, for convenience should be shown in the sketch as above.

Equivalent Length of Each Section

The second step will be to solve for the equivalent length of each of the three sections, or we may say, to compute the equivalent length of one 12-in. line for each of the sections. This is accomplished by the Chezy Equation 14.

SECTION 1.

$$M_1 = \frac{15}{2.6444^2} = 2.1450$$

log of 2.1450 = 0.3314371

SECTION 2.

$$M_2 = \frac{14}{2.99165^2} = 1.5643$$

log of 1.5643 = 0.1943186

SECTION 3.

$$M_3 = \frac{15}{3.33055^2} = 1.3523$$

$$\log \text{ of } 1.3523 = 0.1310593$$

Each should be shown in its proper place in the above sketch.

These equivalent lengths of each section for one 12-in. line cannot be added together for the total equivalent length of the entire station district since the values of the Chezy friction factors of each section are different, due to the difference in the value of N for each section. Since $(f\mu)$ changes with B, there will be a new set of the three friction factors for each change in the value of the discharge B.

Available Friction Head

The third step will be to determine the available friction head for the entire station district for the maximum pump pressure at station A. This will be assumed at 650 lb. per sq. in. for an oil having an observed gravity of 38.0 deg. A.P.I. at a line temperature of 35 deg. fahrenheit.

By Equation 6 we have:

$$h = \frac{(131.5 + 38.0)\ 650}{61.287} = 1797$$

as the pump head in ft. of the liquid being pumped, and, when added to the elevation of the pressure gauge in the discharge manifold at station A, we get:

$$875 + 1797 = 2672 \text{ ft.}$$

the elevation of the hydraulic gradient at station A, from which we deduct the elevation of the surface of the oil in the working tank at station B, or:

$$2672 - 1015 = 1657 \text{ ft.}$$

as the combined friction head for the three sections of the station district.

If the elevation of the surface of the oil in the working tank at station B is taken as the elevation of the hydraulic gradient at the receiving manifold, it is correct, provided, of course, that both stations are running even and there is no flow between the receiving manifold and the working tank, but if station B is running either faster or slower, a pressure gauge should be installed in the receiving manifold in order that the hydraulic gradient may be determined in the same manner as at station A.

Viscosity of the Liquid

The fourth step will determine the kinematic viscosity in poises for the coldest line temperature in the winter. The temperature-viscosity curve for the particular oil to be pumped gives a viscosity of 98.5 Saybolt Universal Seconds (SUS) for a temperature of 35 deg. fahrenheit. Then by Equation 7 we obtain:

$$k = (0.216 \times 98.5) - \frac{180}{98.5} = 19.44$$

as the kinematic viscosity in centipoises or 0.1944 as the kinematic viscosity in poises.

Since the viscosity influence plays such an important rôle in the carrying capacity of liquid flow in a pipe line, whether it be water, gasoline, or crude oil, a few remarks regarding its effect may be considered appropriate at this time.

The effect of the viscosity of water upon its rate of flow was practically ignored by the many hydraulicians who had contributed to the hydraulic literature up to about the year of 1900. Professor Hazen (Williams and Hazen) in a discussion of the Saph and Schroder water-flow experiments in 1902 emphatically stated that from his analysis of all the experimental data used in the development of his formula, the temperature had no effect upon the flow of water in pipes of the size in which the engineer is interested; however, in very small tubes it may influence the flow slightly.

The writer in his analysis of the Saph and Schroder experiments in 1918 clearly found that the head as well as the Chezy friction factor varied directly as the 0.25 power of the kinematic viscosity in centipoises.

The fact is, the experiments published in the hydraulic literature since Couplet (1732) made the first experiments upon pipe flow of which there is any record have been made at temperatures varying from about 40 to 85 deg. fahrenheit, and for such a variation in temperatures the viscosity effect upon the experimental friction factors is about 25 percent, yet Darcy and Bazine in their many thousand water flow experiments upon both pipe and open channels failed to recognize any influence of the temperature of the water upon its rate of flow.

The viscosity effect upon the Chezy friction factor due to temperature change only, for temperatures between the minimum and maximum pipe line temperatures for Mid-Continent light crudes, varies between 33 and 70 percent, while kerosene is about 16 percent and gasoline about 10 percent.

From the foregoing remarks it is very evident that all liquids follow some law of viscous flow which has thus far been distinguished as either turbulent or streamline flow.

Values of the Argument

The fifth step will determine the values of the argument B/DKN for each of the three sections based upon a trial value of B for say 6150 bbl. per hour.

SECTION 1:

$$\left(\frac{B}{DKN}\right)_1 = \frac{6150}{12 \times .1944 \times 2.6444} = 996.9$$

$$\log \text{ of } 996.9 = 2.9986705$$

SECTION 2:

$$\left(\frac{B}{DKN}\right)_2 = \frac{6150}{12 \times .1944 \times 2.99165} = 881.2$$

$$\log \text{ of } 881.2 = 2.9450929$$

SECTION 3:

$$\left(\frac{B}{DKN}\right)_3 = \frac{6150}{12 \times .1944 \times 3.33055} = 791.6$$

$$\log \text{ of } 791.6 = 2.8984816$$

Now that the values of the three arguments are known it would be a simple matter to take their corresponding values of $(f\mu)$ from a table or a curve if one were at hand. In this case the equation of the curve No. 78 appearing on the Graph Fig. 1, will be used to compute the three friction factors.

Of the many forms of curves that might be used for determining the value of the Chezy friction factor in terms of the argument B/DKN, the simplest and probably the most accurate is the straight line in logarithmic plotting.

A thorough understanding of the relation of the exponent of the equation of such a line (Equation 10) bears to the exponents of the equation of the equivalent number of pipes of one diameter equal to that of another diameter (Equation 11) is of great importance, whether the values in the curve equation were determined from very accurate experiments or taken from a line averaging several curves.

This is very essential if the several equations that are used in the complete solution of the problem are to bear a true mathematical relation. Only recently an article was published in which the several equations given did not have a true mathematical relation. Is it any wonder that we now have in the hydraulic literature such a wide variation in the values of the so-called experimental flow factors?

It was previously assumed that the exponent $2n+x/n=19/7$, which gives a slope of $(2\text{-}n)=(x\text{-}1)=w=0.25$ for the argument-friction factor curve on the log graph Fig. 1,

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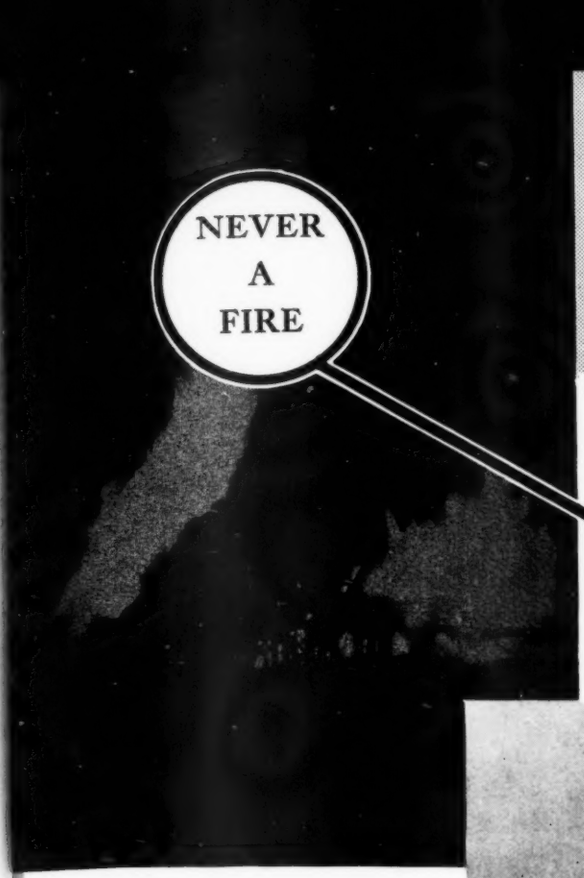

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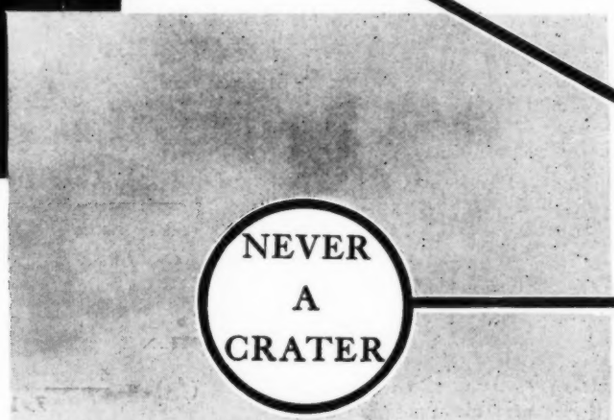

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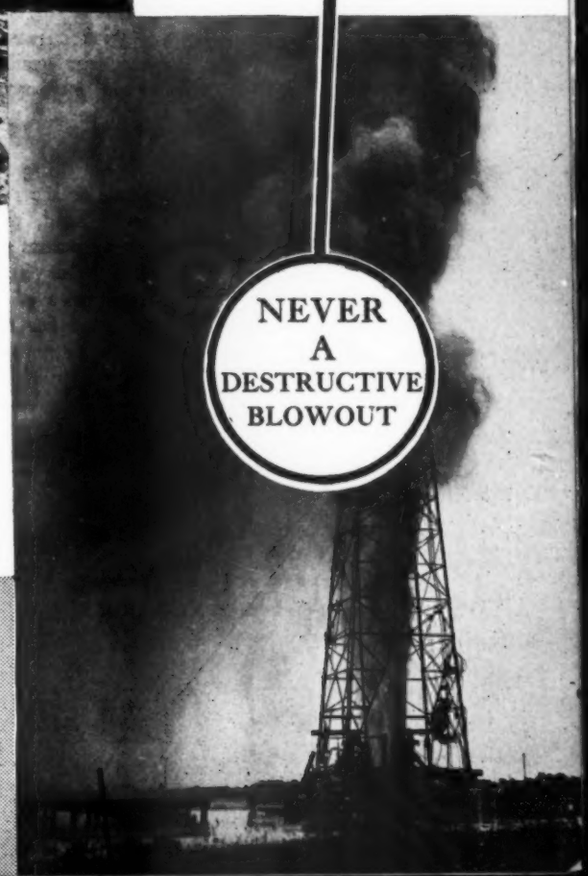

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and it must be used if Equations 10 and 11 are to have the same exponential relation.

It is unfortunate that there is no clear conception concerning the nature of the errors involved when one set of exponents are not used in determining both the relation of pipe diameters and the Chezy friction factor in parallel line layouts. Because of their importance, and the lack of recognition among investigators, a few comments are given here regarding the one fallacy most often used.

The usual procedure is to compute the equivalent number of pipes of one diameter equal to that of another diameter having the same carrying capacity for a given friction head as the square root of the fifth power or 5/2 power of the diameters, then turn to a table or graph of the argument—Chezy friction factor values—and select the friction factor corresponding to the computed value of the argument.

The exponential relation for the exponent $2n+x/n=5/2$ gives a slope value of $(2\text{-}n)=(x\text{-}1)=w=0$, or a horizontal line on the log graph of the argument—Chezy friction factors. Such a line is preposterous as almost every experimenter during the past 85 years has recognized in some form or other the influence of the diameter and the velocity (a few the viscosity) upon the value of the Chezy friction factors of which either one will cause the line to be on a slope.

It is obviously necessary that N, the number of lines of a given diameter, or the equivalent number of lines of a given diameter, be made a factor of the argument, otherwise the value of the friction factor taken from the graph or table will be too small for the actual flow conditions of the lines. This omission is evident in the literature dealing with parallel line flow.

Experimental factors obtained from very careful experiments taken upon parallel line flow where more than one size of pipe is involved, cannot under any circumstances have more than mere approximate values since the values of the exponents x and n or $2n+x/n$ have never been definitely determined from experiments taken upon single line systems for several different diameters of the one category, which includes oil and gasoline flow in wrought-steel and steel pipes, also water flow in brass pipes. If all laboratory experiments are excluded from consideration the remaining published experiments from which the experimental values of the Chezy friction factors may be plotted become nil.

The writer has several hundred of his own experiments taken upon single 8-in. line with a generous assortment of velocities or discharges, where the permissible error in the discharge, pressure and observed gravity is not exceeded, but they do not possess the accuracy required for scientific analysis due to the lack of accuracy in the viscosity of the actual oil flowing during each experiment; however, if all the experiments of any one temperature are plotted, the log discharge against the log friction head, the points fall on a straight line with very few stray points any appreciable distance from the line. The slope of this line is 1.75.

If the temperature-viscosity curve of what this crude is supposed to have been is consulted for the temperatures of the experiments used, and the experimental values are computed for the Stokes form of diagramming, then plotted, the slope of the line is $(2\text{-}n)=0.25$ and is practically an extension of the line of the Saph and Schroder's experiments.

Similar other analysis upon incomplete experimental data by the writer has led him to believe that the probable values for an exponential form of equation should represent a straight line on the Stokes log form of plotting the arguments against the Chezy experimental friction factors and it should have a slope of $(2\text{-}n)=0.25$; however, if investigators and experimenters would publish their actual experiments from which they derive their curves, the subject of hydraulics might develop into a science. No doubt this has not been done for the same reasons previously mentioned.

It should be an unpardonable sin to publish experiments without giving the probable error, plus or minus, for each of the experimental values, namely, the friction head in feet of the liquid being pumped, velocity or discharge, viscosity, and the diameter. Such experiments should only be taken upon a single line that is known to be clean, having the same exact inside diameter throughout its entire length, or the length between points where the pressure is determined.

With a generous assortment of this class of experiments, having a wide range of discharges and viscosities in several different diameters of pipes, the petroleum pipe line engineers could, no doubt, soon develop the subject of viscous flow in pipe lines, into a science. The time and effort would in all probabilities accomplish the results that our predecessors have strived in vain to accomplish since 1750, when Brahms contributed the first step to our present hydraulic formula.

Friction Factors ($f\mu$) Computed

Sixth.—Equation 11 will now be used with exponent $(2\text{-}n)=0.25$ for computing the three required friction factors.

SECTION 1:

$$(f\mu)_1=\frac{4196.56^{2-n}\times .018168}{996.9^{2-n}}=0.02602$$

$$\log \text{ of } 0.02602 = 8.4153629$$

SECTION 2:

$$(f\mu)_2=\frac{4196.56^{2-n}\times .018168}{881.2^{2-n}}=0.02684$$

$$\log \text{ of } 0.02684 = 8.4287573$$

SECTION 3:

$$(f\mu)_3=\frac{4196.56^{2-n}\times .018168}{791.6^{2-n}}=0.02757$$

$$\log \text{ of } 0.02757 = 8.4404101$$

These computed friction factors will be found to have the same values as given by line No. 78 on the graph Fig. 1, for the same arguments.

Computed Friction Head

Seventh.—If we are to use the Chezy equation in our computations, then Equation 16 will be the appropriate one for a system of parallel lines.

An inspection of Equation 16 will reveal that B cannot be solved direct since B and $(f\mu)$ are both unknown. This may be accomplished, however, by solving h for several different values of B, then plot the results on cross-section paper and by extrapolation determine the discharge for the desired available friction head.

To compute the three friction heads the first step will be to solve the value of the first term on the right of the equality sign, Chezy Equation 16, as a multiplier for each section, or:

$$\frac{5181B^2}{2g\,D^5}=\frac{5181\times 6150^2}{64.32\times 12^5}=\;=12243$$

$$\log \text{ of } 12243 = 4.0878887$$

then for each section we have for the head,

SECTION 1:

$$12243\times 0.02602\times 2.1450 = 683.4 \text{ ft.}$$

SECTION 2:

$$12243\times 0.02684\times 1.5643 = 514.0 \text{ ft.}$$

SECTION 3:

$$12243\times 0.02757\times 1.3523 = 456.4 \text{ ft.}$$

and the combined friction head is equal to 1653.8 feet. This is only 3.2 feet less than the available friction head of 1657 ft., and if the lost head due to the gate plant fittings at each gate plant were considered, the 3.2 ft. difference would probably take care of it. Hence we may reasonably expect that 650 lb. gauge pressure will deliver 6150 bbl. per hr. of this particular oil in pipe lines that are known to be clean.

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Phillips Petroleum Company camp at Whittenburg, Texas. This camp, recently completed, consists of 100 houses, 50 three-room and 50 four-room, and is one of the largest camps in the Panhandle region.

Management Problems of Company Camps

By F. B. TAYLOR
Panhandle Eastern Pipe Line Company

WITHIN the past few years, and gaining in advocacy, is the trend to centralize the management and upkeep of company-owned housing facilities under one head. Particularly is this true in comparatively extensive camps. The separation of this charge from other allied departments has proven highly successful in numerous instances.

The peculiar and individual problems involved in camp management require tact and experience. Where a superintendent at a plant or station is required to assume the additional duties of camp manager, he cannot devote the same energy to each job; and usually the camp comes last. The placing of this task in the hands of an individual has eliminated frequent difficulty, and at the same time has more adequately protected a company's major investment.

Two other housing developments of importance have become noticeable recently. First, in the comparison of the modern house to those of years past, the more modern construction has all conveniences commonly found in city residences. Inclosed cupboards, built-in ironing boards, hardwood flooring, screened porches, and weatherproofing are becoming standard. And second, where the place of employment is within a reasonable driving distance to a town, it is seldom that camp construction is sanctioned.

Construction and Maintenance

No absolute figure can be given on construction costs of either single houses, or of groups. Included in the cost of a camp must be figured the price of the location. Enclosing fence, road grading, walks, external fixtures, etc., would also be included in the initial cost, as well as the upkeep.

For a basis of calculations, a four-room house may be contracted and constructed, not as a single unit but as part of a camp, for an average cost of $285 to $550 per room. This figure will include modern specifications, but varies with locations and local costs of labor and materials. A five- or six-room house is from 15 percent to 18 percent less per room.

Considering the per-room cost of a five-room house to be $400, a completed construction would be about $1935. Added to this is external work and supervision amounting to a total of $2289. Actually this figure is conservative, but discloses the fact that the outlay, as an investment and considering the monetary returns, is ineffectual.

Methods of charging accurately all maintenance costs to camps is difficult. Various methods have been tried; the segregation of upkeep to type of work, such as plumbing, wiring, floors, roofing, etc. One company, making no attempt to divide costs, charges repairs of all classes against that particular house, each one being numbered. From a study it was found that for four years on four-room houses, the maintenance costs per room per year was $3.12. This did not include insurance, maintenance of fire equipment or of driveways.

A comparison of construction and maintenance costs establishes a factor of .085 as being a relative maintenance charge per year against the investment. In addition to the $3.12 upkeep is the insurance, general external work, garbage disposal, etc. In many cases gas, electricity, and water are furnished at an additional expense.

Rents vary greatly, but with the larger companies average $10.00 per four-room house, with rent-free rare and occasionally going as high as $25.00. Considering the investment as compared to the first cost, the return from rent established a factor of .0748. Consequently, the usual rent

View of camp of the Continental Oil Company at Borger, Texas. An older camp, well landscaped. Fire-fighting equipment is housed in the compound to the rear of the houses.

return is not quite sufficient to satisfy the maintenance of the property.

This is not true in all cases, although applying to all but the exceptional. Of a total of 686 houses in a number of differently operated camps, the figure was accurate, and only one camp of 14 houses was paying out on the investment.

Free rent has largely disappeared. In some instances where this was a practice, the companies increased salaries an amount equal to the proposed rent, thereafter making a monthly charge.

Aside from the fact that in many cases a camp is a necessity, it is usually advisable in production areas. The employee is not constant, and neither is the work. Any type of protection may be erected, usually in the cheapest possible manner. There can be no question of permanency under such circumstances, and the companies suffer. Tent cities foster discontent and inconstancy that can be overcome almost entirely by proper housing.

Camp Discontent

All problems of camp management are secondary, and very definitely so, to this. Certain rules to be observed have been placed in operation at many camps. They must, of course, be general, and not over inclusive. The following (Fig. 1) have been found pertinent and satisfactory:

Camp Rules

1. That no alterations be made on the premises — either within or outside of houses—without the approval of the camp manager.
2. No electrical appliances shall be used that will create a greater load than a 20-amp. fuse will carry, and all must be manufactured under underwriter's code.
   A. That no alterations or additions to the present wiring system shall be made without the work being done by electrician under the camp manager's supervision.
3. That no additional connections to either water or gas lines be made for any purpose without approval of camp manager.
4. No livestock or poultry will be allowed.
   A. No pens, enclosures, or houses for livestock or poultry of any kind will be allowed.
5. Each individual shall exercise great care in parking automobiles in narrow streets so as to insure ample room for passage of fire truck in case of emergencies—not only for your and your property's protection, but also for others.
6. The occupants of each dwelling will be held responsible for the cleanliness of the premises that they occupy. If the condition of any property does not meet with the camp manager's approval, he has authority to have same cleaned and bill the occupant for such labor.
7. All fire hazards should be removed or called to the attention of the camp manager as a protection to your property and the company's property.

These rules and regulations are promulgated with the thought of making living conditions more pleasant and to create a home-like atmosphere; also, to insure safety to your property.

Such a set of regulations is of great aid to a camp manager, in that they back his own charges.

Gossip, the most insidious of all undermining influences at camps, is difficult to combat. Generally, where the tales carried are not derogatory to a person's character, or where they are so obviously untrue as to bring nothing but ridicule to the carrier, they are ignored. Too often, however, this is not the case.

Certain people are far more prone to carry tales than are others, and usually their true value is quickly apparent, and allowances made. But at the same time, the deliberate twisting of facts always hurts or injures some one. There can be no set rules for such matters; and they do not always "run themselves out."

In one particular instance, gossip caused one of the best families in a large camp to quit and move. That the charges were totally untrue was not known until the party starting the tale tried it the second time. This time there was another move, by special request. There can be no more disturbing element in a camp than a confirmed gossip. Camp occupants, unlike the town dweller, are frequently limited as regards social contacts and this being the case, they should be even more circumspect than townspeople. But no matter if this rule is followed or not, it takes but one manufacturer of tales to cause trouble.

Petty jealousies and supposed partiality bruited about very definitely decrease the value of the affected man's work to the company; moreover, as he comes home tired at night, the knowledge of new intrigue does not increase his home content, whether it has been directed against his family or not.

Such talk is more readily started where adjacent houses are occupied by men in the same department, and on an approximate wage scale. Realizing this fact has prompted two large camps in the Texas Panhandle to house their employees so that men with same or related jobs and salaries would be separated as far as possible. The system proved itself

entirely successful. Small camps cannot be handled on this principle, except seldom.

Experienced camp managers have found that it is almost impossible to allow one party to evade a rule, or to be lenient in some other respect without arousing antagonism toward themselves as well as the party favored. Equally surprising is the fact that employees in positions of minor responsibility are more prone to disobey regulations than are others.

Care of Houses

Certain improvements or additions to each house as constructed are seldom encouraged even though much of such work adds to the value of the house. Pens, coops, enclosures, etc., are seldom tolerated, at least on company property. Pets frequently create a nuisance unless properly cared for.

Numerous complaints were coming in to the camp manager from all the camps in an area that there were too many dogs around. The camps totaled some 600 houses and a canvass proved that there were 291 claimed dogs in the vicinity, besides many unattached. An innoculation order was issued, including a charge of $1.00 for the service. Thirty percent of the dogs immediately vanished. Complaints fell to zero.

The manager of a large group of camps runs the management as nearly parallel with the manner in which a servicing house in a city would operate as is possible. If an occupant reports a bad water pipe, he considers it as much an order as if he were operating his own plumbing house. Other reports of necessary repair are handled in the same manner.

Regular tri-monthly inspections of fire equipment, wiring, paint, woodwork, etc., are general. Such inspections greatly decrease the necessity of later major repairs. This is particularly true of older construction. Fire drill and testing of fire trucks and other fire-fighting equipment is usually under the care of the camp manager.

It is a realized fact of importance that the care taken of a house by an occupant very definitely denotes the type and exactness of the work that employee is doing on the job. A clean, well-kept house is a recommendation to the resident. Not infrequently men have been "let out" on this item alone.

External Care of Camps

With the exception of camps of ten or less houses, all yard work except that immediately adjacent to the houses is taken care of by the company. This service includes care of hedges, trees, general minor repairs, company landscaping, and minor work of a routine character.

The camp of the Continental Oil Company at Borger experienced radio difficulty. Antennas were strung in any manner, producing an unsightly jumble. Each has been replaced with a pole of standard size, and with the company's triangle at the top.

Driveway and road work is all done by company employees. Washhouses have been provided in small camps of some companies for the convenience of the housewives, and are appreciated. Rock gardens and neatly constructed arbors have been encouraged. Vegetable gardens are almost always approved, as are individual flower plots.

Interior decoration is a subject that has received considerable consideration. It is a general rule that all exteriors and interiors as well should be alike. One company allows the occupants to choose their own color scheme. This, however, only if the company believes that the individual will

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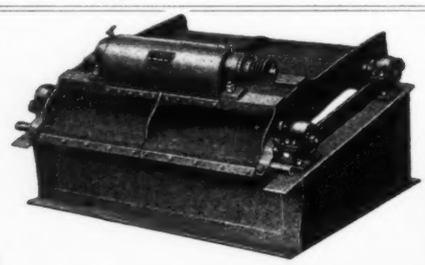

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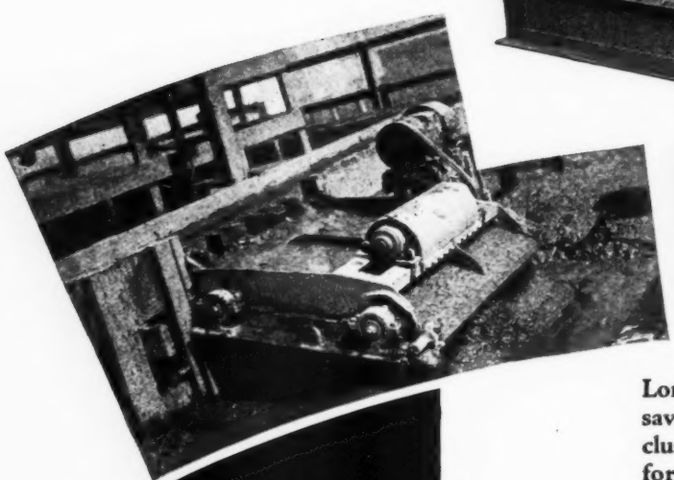

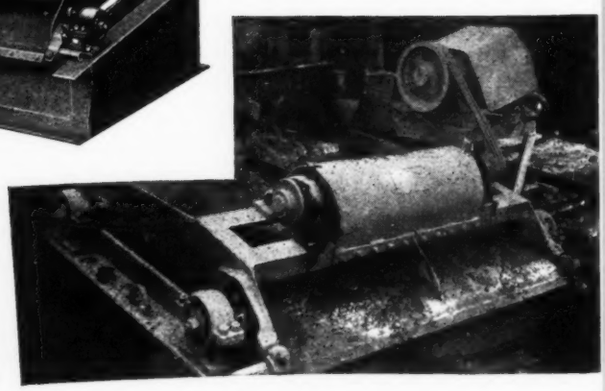

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The **McNEELY**
Vibrating **MUD SCREEN**

be with the company for a satisfactory length of time. This idea has proven highly successful in the one instance, and the increased yearly cost was negligible, the choice of colors being permitted only so far as the interior was concerned.

A point of importance, during construction, and vital in major repairs or additions, is careful and complete filing data on lines buried. Water systems, gates, connections, gas lines, sewerage layouts, and accessory underground equipment must be accurately mapped so that undue cost is not necessary in repairs or connections.

Standardization of equipment in the matter of meters, water heaters, sinks, and other housing interior and exterior completions is being emphasized. Replacements are more readily obtainable and if desirable, a stock of extra equipment may be complete and limited in outlay at the same time; also, this procedure makes possible the interchange of parts without adapters or made-up fittings.

Recreation Facilities

Particularly in large camps it is desirable to have adequate recreation facilities for the school-age children. In many cases portions of the camp property have been set aside for a playground, and swings and other equipment installed. Other forms of self-entertainment are an advantage.

In one camp, a building was given over to the men for the installation of wood-working machinery. The interest was almost unanimous and today the men are turning out professionally excellent home furnishings on their privately-owned equipment.

In other locations golf courses, croquet grounds, tennis courts, and other forms of amusement have been installed by the companies. They are all a means of increasing comradeship. Occupants of such camps point with pride to the advantages. Such additions are well worth the slight necessary expense.

International Acetylene Association Convention November 12-15

The International Acetylene Association will hold its 36th annual convention in Cleveland, Ohio, November 12, 13, 14, and 15. Headquarters will be at the Hotel Cleveland.

This year's meeting shows every indication that it will draw a larger attendance than did last year's record-breaking convention in Pittsburgh, officials of the association announce.

The extensive program now in formation includes a special evening session and the presentation of an inspirational industrial drama. Prominent engineers will discuss new developments in oxy-acetylene applications as related to the individual needs of industry.

A few of the papers to be delivered at the convention are listed below. These subjects and many others will be discussed by nationally-known authorities.

"Welding and Cutting of High Tensile Medium Alloy Steels," "Studies of Oxy-Acetylene Cut Steel Plate," "Hydrocarbon Fuel Gases for Cutting," "High Pressure Piping," "Welding Class I Pressure Vessels," "Maintenance of Way Problems in High Speed Transportation," "Shape Cutting of Locomotive and Car Parts," "Gas Welding of Aluminum and Its Alloys," "Chemical Uses of Acetylene," "Safety in the Oxy-Acetylene Industry," "Prevention of Fires," and "Safe Handling, Storage, and Return of Compressed Gas Containers."

GREEN STRAND

The Hallmark of Hazard

Evidence of the superiority of Hazard wire lines is found in the fact that this company has among its list of customers many firms who have bought Hazard lines continuously for 40 and 50 years.

The finest grade of all Hazard lines is found in the Green Strand. Whether Hazard non-preformed or Lay-Set Preformed, and regardless of their constructions, *all* Hazard lines made of Improved Plow Steel are identified by the Green Strand. Green was chosen as the identifying color because green signifies safety. Being made of Improved Plow Steel, Hazard Green Strand is the *safest* of all wire lines.

When you buy Green Strand, or see it in use—you see wire line of a quality that has kept customers on our books for over a half-century—the wire line that is safest for both men and production.

Hazard Wire Rope Company, *Inc.*
WILKES-BARRE, PENNSYLVANIA
An Associate Company of the American Chain Company, Inc.
In Business for Your Safety

District Offices:
New York, Chicago, Philadelphia, Pittsburgh, Ft. Worth, San Francisco, Denver, Los Angeles, Birmingham, Tacoma

S. M. "Puny" Blevins Joins Sales Staff Gustin-Bacon

S. M. "Puny" Blevins, all-time football star of Tulsa University, has joined the sales organization of the Gustin-Bacon Manufacturing Company, and will act as a representative of that company in its Tulsa office. This company is the authorized representative of Goodyear in the Mid-Continent and Gulf Coast fields—and manufacturers of Rolagrip Pipe Coupling and Rokflos insulation.

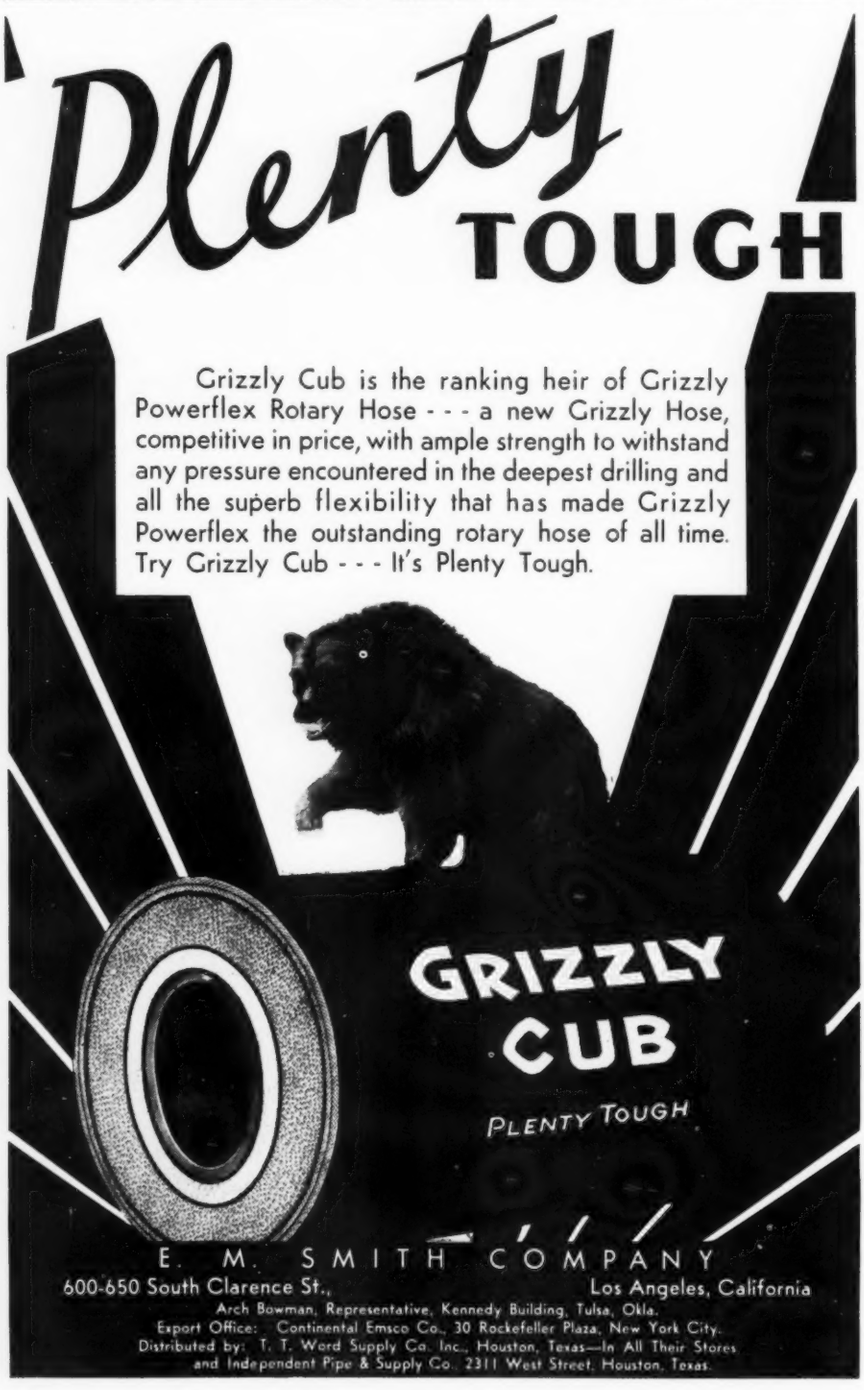
International Petroleum Exposition Promises to Be Largest Yet, Says W. B. Way

Plans for the ninth International Petroleum Exposition, to be held in Tulsa May 16 to 23, 1936, are under way and the upward surge of oil and general business conditions point toward the largest exposition yet held, says General Manager W. B. Way.

"Exhibitors are asking for increased space compared with the 1934 show. Space is 86 percent sold. Outside exhibit blocks are 92 percent contracted for and 81 percent of the booths in the five large exhibit buildings are sold," he said.

"The Oklahoma and Texas buildings are completely sold out and the Scientific and Technical, and Refiners and Marketers buildings are 60 to 70 percent sold." Way predicts that there will be a complete sellout of space by December 1.

The Scientific and Technical Committee will again be headed by W. A. Schlueter, president of the Refinery Supply Company, and he has appointed a strong committee that already is at work. The committee members are: H. W. Camp, general superintendent of refineries, Empire Oil and Refining Company; R. C. Cattell, U. S. Bureau of Mines, Bartlesville, Oklahoma; M. G. Colby, chief chemist, Sinclair Refining Company, Sand Springs, Oklahoma; Frank Craver, geologist; Roy Ginter, Ginter Chemical Laboratory; L. S. Gregory, consulting engineer; Alf. G. Heggem, president, Oil Well Improvements Company, Tulsa; Frank Holsten, vice-president and general manager, Barnsdall Refining Corporation; Emby Kaye, vice-president in charge of refineries, Skelly Oil Company; Kent K. Kimball, geologist; B. W. Logue, chief chemist, The Texas Company; F. L. Martin, vice-president, Sunray Oil Company; Walter Miller, vice-president, Continental Oil Company, Ponca City, Oklahoma; G. G. Oberfell, vice-president and research director, Phillips Petroleum Company, Bartlesville; Roy Parker, chief chemist, Oklahoma Natural Gas Corporation; W. W. Schuemann, chief chemist, Empire Oil and Refining Company, Okmulgee, Oklahoma; Don Sillers, superintendent of gas measurements, Lone Star Gas Company, Dallas, Texas; W. K. Whiteford, vice-president and general manager, British American Oil Producing Company; D. C. Williams, superintendent, Kay County Gas Company, Ponca City; P. L. Willson, Willson Radio Laboratories.


Plenty TOUGH
Grizzly Cub is the ranking heir of Grizzly Powerflex Rotary Hose - - - a new Grizzly Hose, competitive in price, with ample strength to withstand any pressure encountered in the deepest drilling and all the superb flexibility that has made Grizzly Powerflex the outstanding rotary hose of all time. Try Grizzly Cub - - - It's Plenty Tough.
GRIZZLY CUB
PLENTY TOUGH
E. M. SMITH COMPANY
600-650 South Clarence St., Los Angeles, California
Arch Bowman, Representative, Kennedy Building, Tulsa, Okla.
Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York City.
Distributed by: T. T. Word Supply Co. Inc., Houston, Texas—In All Their Stores and Independent Pipe & Supply Co. 2311 West Street, Houston, Texas.

Republic Steel Receives Award for Outstanding Advertising Campaign

For the most outstanding advertising campaign of the year in the field of metals Republic Steel Corporation was awarded first prize by judges at the 13th Annual Conference of the National Industrial Advertisers' Association, held at Pittsburgh on September 18, 19, and 20.

S. A. Knisely, advertising and sales promotion manager of Republic, states that the prize-winning campaign was created and placed by G. M. Basford Company, industrial advertising agency, with offices in New York and Pittsburgh.

Independent Petroleum Association Meeting Promises to be of Unusual Interest

With reservations reported coming in steadily, and with General Chairman E. L. Smith putting the finishing touches on a well rounded out program, the sixth annual meeting of the Independent Petroleum Association of America, to be held at the Baker Hotel, Dallas, Texas, November 4 and 5, promises to be a well-attended and worthwhile affair.

WIRT FRANKLIN
President, I.P.A.A.

The Dallas meeting will be of unusual interest. Failure of the recent Congress to pass several measures outlined and approved at the annual meeting of the association at Fort Worth, Texas, last December, including limitation of imports, limitation of withdrawals from storage, federal allocation of quotas for movement in commerce, and creation of a federal agency to administer the law, will be taken up. Plans for the continuance of its fight for a balance between crude oil production and demand also will be outlined and passed upon at the Dallas meeting.

The Independent Petroleum Association of America has a membership in 36 states, with directors in all the oil-producing states of the Union. Affiliated with the association are approximately 30 independent local, area, and state associations. Advance registration indicates a large representative attendance from each of these bodies.

Many delegates from eastern and northern states are planning to attend both the meeting of the Independent Petroleum Association of America at Dallas and the annual meeting of the American Petroleum Institute at Los Angeles, November 11 to 14. They will take advantage of the special convention train that will leave for the west coast immediately following the close of the Independent Petroleum Association's meeting.

Reservations for the Dallas meeting should be made through H. B. Carpenter, Secretary, Dallas Committee, 1209 Magnolia Building, Dallas, Texas.

F. F. Chiles Goes with Republic Steel

Frank F. Chiles, formerly manager of sales of the Bar Division of Corrigan, McKinney Steel Company, has been appointed assistant manager of sales of the Bar Division, Republic Steel Corporation, with headquarters at Youngstown, Ohio, according to an announcement by N. J. Clarke, vice-president in charge of sales for Republic. The appointment is effective immediately.

In his new capacity, Chiles will assist W. F. Vosmer in supervising the sales of all carbon semi-finished steel bars, shapes and plates produced by Republic.

AXELSON

PUMPS AND SUCKER RODS IN EVERY WELL WILL SAVE YOUR INVESTMENT MANY TIMES OVER

AXELSON MANUFACTURING CO.
P. O. Box 710, Vernon Station, Los Angeles
St. Louis 50 Church St., New York Tulsa
Mid-Continent and Eastern Distributor: Frick-Reid Supply Corp.
Rocky Mountain Distributor: Great Northern Tool & Supply Co.

Heaviest String of Casing Landed in Well in Texas Gulf Coast

Only last month (p. 56, September issue) the fact was published that the heaviest string of casing had been run in a well of the Union Oil Company of California in the Kettleman Hills field. Since this item appeared a still heavier string of casing has been run.

On September 30, the Sun Oil Company landed at a depth of 8210 ft. a string of 9⅝-in. casing the total weight of which was approximately 348,000 lb., or 174 tons. It was composed of 3974 ft. of 44.30-lb. casing, the rest being 40-lb. regular grade "D" casing. This string of pipe was landed and cemented with 500 sacks of cement in the Sun Oil Company's Broussard & Hebert No. 1, a wildcat well at LaBelle, Texas, which is some twenty miles south of Beaumont on the Texas Gulf Coast.

To Co-operate in Manufacture and Sale of Piston Rings

Announcement is made that a contract has been consummated whereby the American Hammered Piston Ring Company, Baltimore, Maryland, and The Skinner Chuck Company, New Britain, Connecticut, are to cooperate in the manufacture and sale of Gold Seal and Silver Seal piston rings.

For the last four years The Skinner Chuck Company has been carrying on laboratory and field tests on rings with peripheral anti-friction metal inserts, in which tests the American Hammered Piston Ring Company has cooperated. The results obtained have proven the merit of this type of ring to the satisfaction of the American Hammered Piston Ring Company and they have added these items to their line of rings for industrial uses.

These rings have been adopted as standard equipment by such well-known firms as the Westinghouse Electric and Manufacturing Company in their Diesel engines, and the Frick Company in their high capacity refrigerating machinery, it is stated.

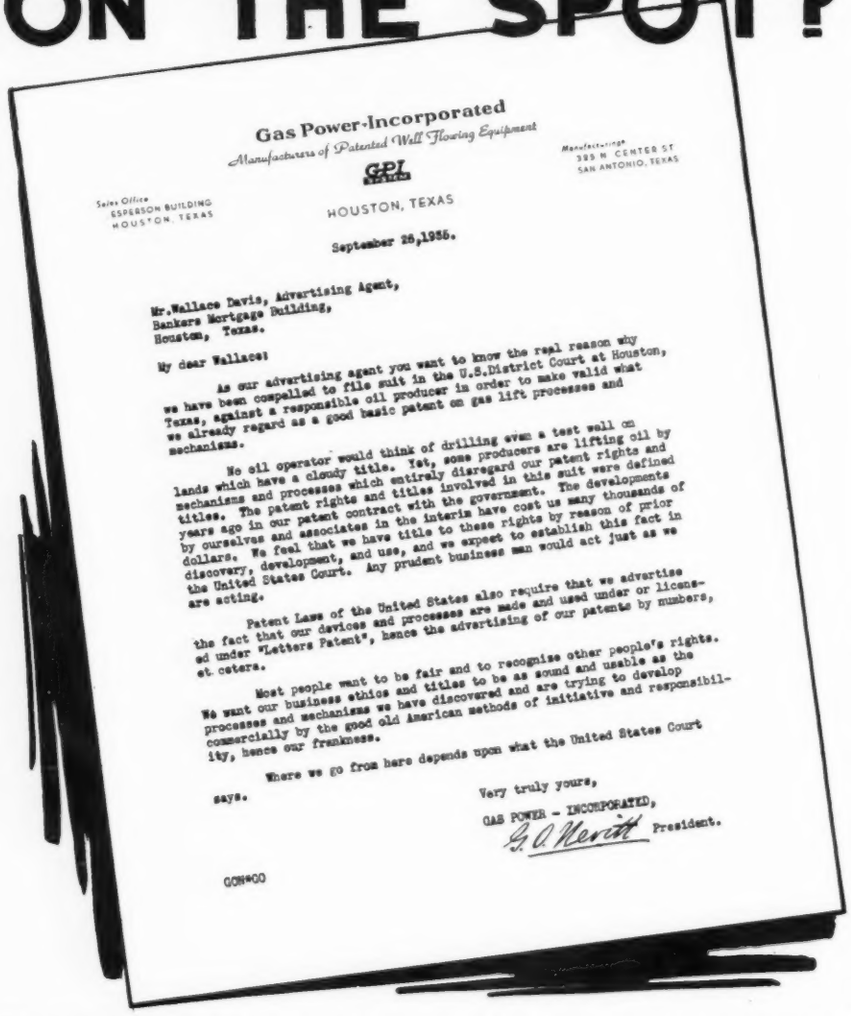
It is possible that at a later date the American Hammered Piston Ring Company may also offer Gold Seal piston rings for automotive use.

Gold Seal piston rings are rings with bronze inserts around the periphery and are used in internal combustion engines of all types, steam engines, compressors, etc.

Silver Seal piston rings are rings with inserts of babbitt or similar white metal alloy for use in refrigerating machinery and other places where ammonia or other chemical present prevents the use of bronze.

The high unit pressure of the narrow bearing strips against the cylinder walls gives a quicker initial seat, which tends to prevent blow-by in either out-of-round or tapered cylinders, it is pointed out by the American Hammered Piston Ring Company. As the bearing metal wears, it burnishes the cylinder walls and allows the cast-iron ring to reach a seat very gradually. The addition of the anti-friction metal strips to the cast-iron ring eliminates scuffing and reduces ring and cylinder wear, it is stated.

Are You Among Those ON THE SPOT?



Gas Power-Incorporated

Manufacturers of Patented Well Flowing Equipment

GPI

Sales Office ESPERSON BUILDING HOUSTON, TEXAS

Manufacturing 325 N. CENTER ST. SAN ANTONIO, TEXAS

HOUSTON, TEXAS

September 28,1956.

Mr.Wallace Davis, Advertising Agent,
Bankers Mortgage Building,
Houston, Texas.

My dear Wallace:

As our advertising agent you want to know the real reason why we have been compelled to file suit in the U.S.District Court at Houston, Texas, against a responsible oil producer in order to make valid what we already regard as a good basic patent on gas lift processes and mechanisms.

No oil operator would think of drilling even a test well on lands which have a cloudy title. Yet, some producers are lifting oil by mechanisms and processes which entirely disregard our patent rights and titles. The patent rights and titles involved in this suit were defined years ago in our patent contract with the government. The developments by ourselves and associates in the interim have cost us many thousands of dollars. We feel that we have title to these rights by reason of prior discovery, development, and use, and we expect to establish this fact in the United States Court. Any prudent business man would act just as we are acting.

Patent Laws of the United States also require that we advertise the fact that our devices and processes are made and used under or licensed under "Letters Patent", hence the advertising of our patents by numbers, et cetera.

Most people want to be fair and to recognise other people's rights. We want our business ethics and titles to be as sound and usable as the processes and mechanisms we have discovered and are trying to develop commercially by the good old American methods of initiative and responsibility, hence our frankness.

Where we go from here depends upon what the United States Court says.

Very truly yours,

GAS POWER - INCORPORATED,

G. O. Merritt President.

GOM:CO

The GPI SYSTEM of flowing wells is protected by numerous patents and hundreds of claims, as well as patents applied for. The policy of Gas Power-Incorporated will be to enforce their rights under these patents. Copies of the following patents already issued will be furnished to interested, responsible parties, in order that everybody's rights may be defined and protected:

1,312,442	1,310,615	1,509,323	1,526,723	1,572,329	1,572,330
1,572,331	1,572,332	1,572,333	1,738,974	1,777,536	1,803,683

W. C. Trout Returns from Trip

W. C. Trout, president, Lufkin Foundry and Machine Company, Lufkin, Texas, has returned from a business trip to the north and east during which time he visited the Machine Tool Show in Cleveland and selected numerous new tools for production requirements, a part of the recent expansion program undertaken by this Lufkin manufacturer of pumping equipment.

Holmes Smith to Sales Staff Oil Center Tool Company

HOLMES SMITH

Holmes Smith has been appointed to the sales staff of Oil Center Tool Company after about one year as chief inspector in the company's plant. Smith has been assigned to the Southwest Texas district as assistant sales manager.

Joe A. Coulson Closely Identified with Drilling Mud Development

JOE A. COULSON

Joe A. Coulson, manager of Colox Sales and Service, division of Geo. S. Mepham Corporation, has been a prominent figure in the development of commercial drilling mud from the early pioneer stage to its present universal use. When the original experimental work was being done by the Department of Conservation in Louisiana on drilling muds, the Mepham organization, through Coulson, furnished the materials and supplied samples in coöperation with the department. Coulson, 16 years with the Mepham organization, maintains headquarters in Houston, Texas, to direct the Colox engineering staff.

New Mid-Continent Supply Representatives

Bryan Wilcox, well-known in the petroleum equipment industry, formerly at Houston, Texas, has joined the sales staff of the Mid-Continent Supply Company, Mid-Continent Building, Fort Worth, Texas, where he will make his headquarters, contacting the Dallas and Fort Worth trade.

G. E. Tyson, for many years with the Reading Iron Company, recently became connected with the Mid-Continent Supply Company also. Tyson is now district tubular manager for the Mid-Continent with headquarters at the company's offices in Houston, Texas.

Fred J. Spurlock, with the Axelson Manufacturing Company for many years, is another recent addition to the sales staff of the Mid-Continent Supply Company. He will be in charge of pumping equipment sales, with headquarters at Mid-Continent's offices, Houston, Texas.

C. L. Hudson, well-known in the oil well supply business, recently joined the sales department of Mid-Continent and for the present will have headquarters at Beaumont, Texas, working under the supervision of the Mid-Continent's division offices at Houston, Texas.

Engineered
TO MEET OPERATING CONDITIONS

Here's an ANCHOR

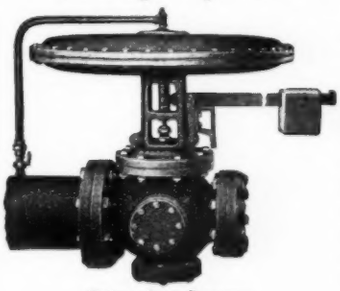
. . that makes it possible to PUMP from any LEVEL . . without necessity of pulling or moving tubing . .

Send for descriptive data or ask your favorite supply store to tell you the story of this simple, sturdy and effective unit. No common working barrel or seating device is needed. Low cost . . . plus a substantial saving of time, pulling costs and lost production.

B-M-W ADMORE
Insert Pump Anchor

BRADFORD MOTOR WORKS INC.
OIL WELL SUPPLIES
BRADFORD, PA. — TULSA, OKLA.
EXPORT OFFICE, 30 CHURCH ST. NEW YORK CITY

VALVE SEATS RENEWED
without Disturbing the Body of the Regulator

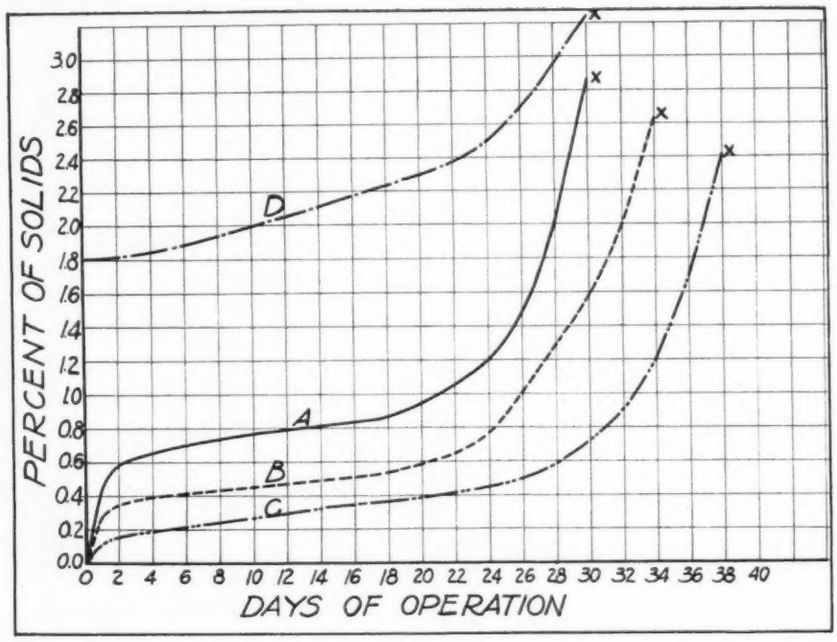


Fulton Low-Pressure Regulator

CF

THE Fulton Low-Pressure Regulator can be fitted with new valve seats if desired, with the body of the regulator remaining undisturbed in the line. Plain directions will be mailed to any user on request. This regulator is capable of taking relatively high inlet pressures and reducing to the correct pressure for use. If the purpose is to deliver a very low pressure, the diaphragm surface is made very large so that the regulator becomes highly sensitive to any variation at the outlet and adjusts itself to compensate. Action is exact, positive and sure. Changes of pressure on the inlet side are therefore without effect on the delivered pressure. If gas supply should fail, automatic cut-off is provided. This Regulator is easy to install, never sticks, gives unfailing satisfaction. One of a line of regulators for all needs of gas control which has been known and approved for forty years. Catalog on request.

The Chaplin-Fulton Manufacturing Co.
28-40 Penn Avenue Pittsburgh, Pa.



Curves, plotted from centrifuge tests, showing how condition of oil in crankcase changes with use

By
ELTON STERRETT

Centrifuge tests made regularly yield information on rate and degree of oil pollution

Checking Condition of Oil in Crankcase

POLLUTION of crankcase oil with carbon formed by breaking down some of that same lubricant is one of the most prolific causes of engine wear and ultimate failure, yet there seems to be no established method for determining the degree of pollution, no definite standard for changing. The commonest plan is to renew the oil at stated periods; the most frequent rule being to change every month, or on a basis of 720 hours of operation.

Nearly every pipe line station powered with internal combustion engines includes in its equipment a bit of apparatus that may be used advantageously to keep a check on the lubricant, though its value in this manner is not generally appreciated. The centrifuge, either hand- or motor-driven, is well-nigh universally provided for checking the B.S.&W. content of the crude being received and pumped.

This same centrifuge may be used equally as well for shaking out samples of crankcase oil; and will give results startlingly clear and, in many cases, unpleasantly surprising to the engineer in charge of the station.

In one main line station watch has been kept for more than a year over the oil by the means suggested, a sample being drawn from each power unit every 24 hours over the period between changes, and a record kept of the readings obtained. Samples for this test were drawn from the pressure oil line, after passing through the oil filter, and thus gave a true picture of just what was being supplied the engine main bearings.

In shaking out a sample, conditions approximating those for a crude test were followed. The oil was diluted with gasoline, 100 percent by volume being added, and the resultant mixture heated to 120 deg. fahr. in a water bath. The test was whirled at standard speed, 1500 r.p.m., for 20 minutes and the percentage of solids then read. After a few tests had been rerun for as long as one hour without bringing down any appreciable amount of additional suspended carbon, the 20-min. run was tentatively adopted as standard.

So thoroughly is the carbon compacted in the bottom of the tube by the run that, if the oil above the solids be too cloudy to permit an accurate determination, the liquid can be poured off without materially reducing evaluation of the precipitated material.

The accompanying table and set of curves are from typical logs obtained during the year, and correspond closely to values in any others of the runs where the unit under observation was operated without protracted shut-down or extreme load variation during the period. Curve "A", covering data listed under the same letter, covers the run of a four-cylinder, 200-hp. vertical natural gas engine, from which the old oil was drained and the interior of the crankcase wiped down prior to beginning the compilation. To simplify the plotting and shorten the table without abstracting any of the vital data, only every other day's values are given, except for the first day after the oil change.

As the curve shows, the oil, tested as the 12-gallon supply was being run into the engine, was perfectly clear of suspended matter at the start. After one day's run, however, the percentage of solids jumped to 0.46; due to the new oil washing down the interior of the pistons, the crankcase walls, and carrying in it some of the already formed carbon not reached by the oiler while wiping down. At the end of 48 hours practically all the previously deposited carbon seems to have been taken up by the new oil, as the values then continue to increase at a fairly even rate until the 18th day.

Make-up oil, at the rate of one gallon each six hours if needed, is added to that already in the engine, control being obtained by an automatic device that admits new oil as soon as the crankcase level drops below a predetermined point. From the curve, this make-up oil appears sufficient to take care of lubrication demands until the 18th day is reached,

after which the percentage of solids rises rapidly. Change of oil was made on completing the 30-day run, with a final reading of 2.85 percent solids heavy enough to be brought down by the centrifuge.

Translating this figure of 2.85 percent into quantities, it means that out of each 100 gal. of lubricant supposedly pumped over the main bearings, almost three gal. were solid material—and an abrasive. True, there seems to exist a widespread belief among station engineers and operators that free carbon in the oil is beneficial. Perhaps that carbon which still remains in the oil after the shake-out is fine enough to come under this heading; but any engineer who is willing to believe such solids as may be shaken out are helpful to engine bearings need only rub a bit of the stuff under his finger tip on any smooth, polished surface—such as a piece of plate glass or a watch-case—to be convinced by the network of tiny scratches resulting that the engine bearings would be better off with less carbon.

Curve "B" happens to be from the same unit as gave the results plotted in "A", but the basic data were procured two months later, while the unit was operating at about one-quarter full-load rating. As before, the carbon content of the lubricant increased sharply immediately, and showed a steady gradient until, in this case, the 22nd day is reached. Had this oil been changed under usual routine at 30 days, it would have held only 1.58 percent solids, and the unit was actually run four additional days before the centrifuge readings showed the pollution was increasing at a rate to make the line almost vertical on the graph.

Curve "C", from an engine that had previously given data checking closely with "A" when merely wiped down as thoroughly as possible at the time of an oil change, covers operation after the unit had been thoroughly hosed down with a light oil—in this case, gas oil with one gal. of semi-Diesel added for each four gal. of the other—the entire engine interior being washed. The job was done with an air jet, and the crankcase base thoroughly cleaned after the wash-down.

In "C" the comparatively slight one-day jump of the curve shows how effective the washing job was, and the consistently lower values of solids seem to indicate that the formation of carbon is, under usual conditions, largely assisted by carbon already present. In this curve the "break," or point where the climb becomes rapid, does not occur until the 28th day, or ten days later than when the engine is merely wiped clean. Even at the end of the 38th day, when the oil was changed, the pollution registered only 2.4 percent; a value lower than that at which the change had been ordered in the other cases cited.

To afford a comparison of lubricant conditions between engines of the type tested, where a small quantity of crankcase oil is carried and to which additions are being constantly made, and one in which a large reservoir is used, Curve "D" is given. This shows the results of shake-out tests on reclaimed oil from a 400-hp., 4-cylinder vertical Diesel burning East Texas crude.

The engine carried a 40-gal. oil supply in the base, from which the oil was drained at monthly intervals and run through a reclaimer. The oil was measured after cleaning, fresh lubricant being added to bring the quantity up to the specified amount.

Much to the surprise of everyone concerned, the initial shake-out gave a solids percentage of 1.8—a figure equalled or passed with every sample subsequently tested—and one not lowered even by re-running the oil through the reclaimer. According to the "break" in the plotted data, the oil should have been drawn off by the 22nd day, instead of being used on till the 30th, when a final reading of 3.25 percent solids was obtained.

Use of the centrifuge for this series of tests demonstrated that the useful life of the oil is dependent upon (1), the percentage of full power rating demanded from the engine; (2), the degree of cleanliness attained in the crankcase at the time of making an oil change; and (3), removal of all dirty or "worn" oil at each change. Through the use of a centrifuge, frequency of oil changes can be scheduled—using any stated percentage of suspended solids decided upon as a standard, just as 2.5 percent was adopted in the station where some of the tests were made; thus the changing of lubricant is definitely placed upon an engineering, instead of a rule-of-thumb, basis, and longer engine life assured.

PERCENT SOLIDS IN CENTRIFUGE RUNS

	ENGINE NUMBERS			
Days Run	A	B	C	D
0	0.0	0.0	0.0	1.8
1	.46	.31	.12	
2	.59	.36	.16	1.82
4	.66	.4	.19	1.85
6	.7	.42	.22	1.88
8	.74	.44	.24	1.94
10	.77	.46	.28	2.0
12	.8	.48	.31	2.06
14	.82	.5	.33	2.1
16	.84	.52	.36	2.16
18	.87	.54	.37	2.23
20	.94	.58	.39	2.3
22	1.05	.65	.42	2.37
24	1.2	.76	.45	2.48
26	1.44	1.0	.5	2.7
28	2.0	1.3	.58	2.95
30	2.85X	1.58	.72	3.25X
32		2.0	.9	
34		2.6X	1.2	
36			1.7	
38			2.4X	

X—Oil change.
A—Gas engine, full load.
B—Gas engine, quarter load.
C—Gas engine, full load, crankcase washed.
D—Diesel engine, reclaimed oil.

The large tube of the motor-driven centrifuge makes reading the percentages of solids easy—and handles enough oil to minimize possible errors in sampling

LUFKIN

No. 599 WIPER

will fit ALL

LUFKIN Oil Gagers Tapes

This strong compact wiper is designed to fit *all* LUFKIN Oil Gagers Tapes. Can be attached to tapes now in the field, or to obtain it on new tapes, order them "With 599 Wiper." Small pads, on which the tension is regulated by a thumb screw, wipe oil from line as it is being rewound.

Send for Circular or Catalog.

THE LUFKIN RULE CO.

SAGINAW, MICH.

HOTEL BILTMORE

. . . in Oklahoma City, combines all the features of the modern metropolitan hotel at its best. All rooms have three-channel radio and every other possible convenience.

You'll find the food and service in both the Main Restaurant and Coffee Shop in keeping with Hotel Biltmore standards. The Hotel's downtown location makes theatres and shops easily available.

Room rates start at $2.50

M. J. Conley on Trip for Globe

M. J. (Bud) Conley left California the middle of September for a trip of several weeks' duration through the Mid-Continent and adjacent areas. Before returning he also will visit New York on business for Globe Oil Tools Company of Los Nietos, California.

Union Carbide and Carbon Corporation Exhibits at National Metal Exposition

New important developments in oxy-acetylene welding and cutting, hard-facing, ferro-alloys and alloy steels were displayed and demonstrated by three units of Union Carbide and Carbon Corporation at the National Metal Exposition, September 30-October 4, 1935, in Chicago.

Of many actual live demonstrations presented by The Linde Air Products Company, the operation of the new Oxweld Shape-Cutting Machine, Type CM-12 should be of unusual interest. This machine features dual control, and incorporates modern mechanism of new design for highly efficient operation and extreme precision. In addition, smaller portable cutting machines were demonstrated. Attracting particular attention were other live demonstrations of the oxy-acetylene process, including the use of the multi-flame Lindeweld head, new cutting blowpipe, rivet cutting nozzles, and improved welding methods and apparatus. One of the most timely was the welding of stainless steels with the newly developed Oxweld Columbium-Treated 18-8 Stainless Steel Rod, that gives exceptional resistance to intergranular corrosion.

The exhibits of Electro Metallurgical Company featured the use of two new ferro-alloys, ferrocolumbium, and high nitrogen ferrochrome. Of particular interest was the display showing the effects imparted to stainless steels by the inclusion of the new commercial element, columbium. Its ability to eliminate intergranular corrosion while maintaining high strength, good ductility, and practical malleability in the alloy were demonstrated.

The unique ability of the cobalt-chromium-tungsten alloy, Haynes Stellite, to withstand wear and abrasion was shown by Haynes Stellite Company. The already popular live demonstration of red hardness that drew such wide attention at last year's Metal Show again attracted wide interest. In this operation a Haynes Stellite J-Metal cutting tool, with the cutting tip maintained at a bright red heat, cut a steel billet continually. In addition the resistance of certain special alloys to corrosive action was demonstrated. Of particular interest to this year's visitors were live demonstrations showing the application of Haynes Stellite for giving longer life to industrial wearing parts.

Gordon Greene Goes With Robinson Orifice Fitting Company

GORDON GREENE

After serving the Associated Oil Company of California for 13 years as a gas measurement engineer, Gordon Greene has become affiliated with the Robinson Orifice Fitting Company of Los Angeles as sales engineer. His appointment was effective in September.

During Greene's long connection with Associated Oil Company he engaged in gas accounting, measurement, and other related work. He is well known on the Pacific Coast, having held various committee posts with the Southern California Meter Association, and was chairman of committees for the California Natural Gasoline Association. He will be in complete charge of western sales for the Robinson organization.

S. M. Jones Company Holds Annual Sales Meeting

The annual sales meeting of the S. M. Jones Company was held at the Tulsa Hotel, Tulsa, Oklahoma, October 1 and 2.

The sales program for the coming year was discussed and each of the territory men presented his views on various phases of the business. The theme of the meeting was "Fitting Sucker Rods to Pumping Conditions." Plans for sales promotion work, engineering cooperation with producers, projects for analyzing wells, together with the advertising and direct mail plans, were discussed.

P. C. Jones, president of the company, was in attendance. Among those present were Paul Jones, vice-president; Mason Jones, secretary; D. R. Dale, chief engineer, and other members of the sales and engineering divisions.

Frick-Reid Opens New Store at Rodessa, Louisiana

The Frick-Reid Supply Corporation, Tulsa, Oklahoma, recently opened a new store at Rodessa, Louisiana. The local store manager is F. S. Stagg, with the store operating under the direction of H. C. White, Shreveport, district sales manager.

W. A. Irvin Speaks at Banquet American Society for Metals

William A. Irvin, president of the United States Steel Corporation, addressed members of the American Society for Metals at their annual banquet held October 3 in the ballroom of The Palmer House, Chicago. The annual banquet was one of the highlights of the Society's program during the week of the Metal Show.

R. P. Kilsby Promoted by Babcock & Wilcox

The Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania, announces the appointment of R. P. Kilsby to the managership of its western sales territory. Kilsby will have jurisdiction over all the districts covered by its offices west of the Mississippi River and will make his headquarters at the company's Chicago office in the Marquette Building. Kilsby was formerly attached to the general sales office of the company at Beaver Falls.

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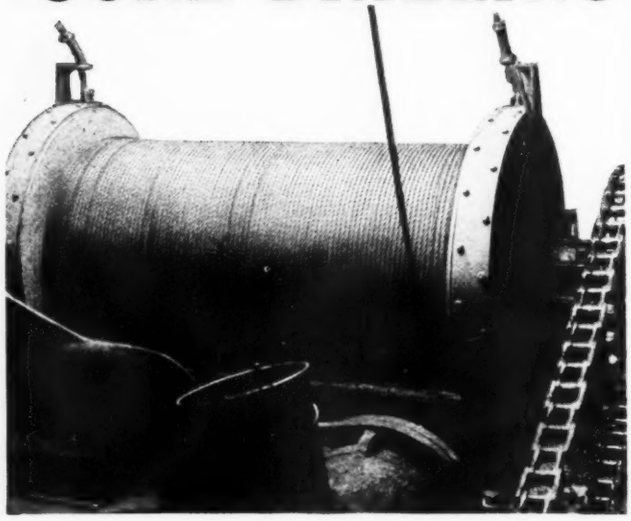

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INDEX *to* ADVERTISERS

American Cable Co.	106
American Hammered Piston Ring Co.	12
American Iron & Machine Works Co.	
American Meter Co.	
American Petroleum Institute (California Convention)	11
American Sheet & Tin Plate Co.	23
American Steel and Wire Co.	10
Anderson, Alexander, Inc.	
Armstrong Bros. Tool Co.	105
Axelson Manufacturing Co., Ltd.	99
Baash-Ross Tool Co.	78
Baker Oil Tools, Inc.	90
Baroid Sales Co.	83
Bradford Motor Works	101
Bridgeport Machine Company, The	
Broderick & Bascom Rope Co.	41
Byron Jackson Co.	P-5
Cavins Co., The	65
Chaplin-Fulton Mfg. Co., The	101
Chapman Valve Manufacturing Co., The	
Climax Molybdenum Co.	
Continental Supply Co., The	61
Cook, C. Lee, Mfg. Co.	63
Cooper-Bessemer Corporation, The	37
D. & B. Pump & Supply Company	
Dresser, S. R., Manufacturing Co.	
Eagle-Picher Lead Co., The	3
Eastman Oil Well Survey Co. of Texas	
Edwards, E. H., Company	16
Elliott Core Drilling Co.	24
Emsco Derrick & Equipment Co.	57
Ensign Carburetor Co.	
Fluid Packed Pump Co.	64
Frick Reid Supply Corp.	5
Gaso Pump & Burner Manufacturing Co.	
Gas Power, Incorporated	100
General Electric Co.	2
Globe Oil Tools Company	75
Gott, H. P., Manufacturing Co.	105
Guiberson Corporation	
Halliburton Oil Well Cementing Co.	
Hazard Wire Rope Co.	97
Hughes Tool Co.	Back Cover
Hyatt Roller Bearing Co.	53
Hydrauger Corporation, Ltd.	105
Hydril Company	P-3
Industrial Brownhoist Corp.	
International Derrick & Equipment Co.	
International Harvester Company of America	84
International Petroleum Exposition	
Jones & Laughlin Steel Corporation	
Kerotest Manufacturing Co.	Inside Back Cover
Kobe, Inc.	9
Lane-Wells Co.	80
Leschen, A. & Sons Rope Co.	14
Linde Air Products Co.	89
Lufkin Foundry & Machine Co.	39
Lufkin Rule Co.	104
MacClatchie Mfg. Co.	66
Martin-Decker Corporation	
Mason-Neilan Regulator Co.	19
Mepham, Geo. S., & Co.	87
Merco-Nordstrom Valve Co.	7
Metric Metal Works	
Mission Mfg. Co.	43
Moore, Lee C., & Co.	Front Cover
National Supply Companies, The	45
National Tube Co.	
National Tube Co. (Stainless)	
O. C. S. Mfg. Co., The	
Oil Center Tool Co.	
Oil Well Supply Co.	55
Oklahoma Biltmore Hotel	104
Oxweld Acetylene Co.	89
Parkersburg Rig & Reel Co.	93
Patterson-Ballagh Corporation	6
Petroleum Electric Power Club	8
Petroleum Rectifying Co.	47
Pittsburgh Equitable Meter Co.	7
Prest-O-Lite Company, Inc., The	89
Reed Roller Bit Co.	
Republic Steel Corporation	49-50
Shaffer Tool Works	59
Smith, E. M., Co.	98
South Chester Tube Co.	
Sperry-Sun Well Surveying Co.	105
Titusville Iron Works Co., The	
Tretolite Company	Inside Front Cover
Trimont Manufacturing Co.	
Union Carbide & Carbon Corporation	89
Union Carbide Sales Co.	89
United States Rubber Co.	
Union Wire Rope Corporation	
U. S. Steel Corporation Subsidiaries	10, 23 and 55
Vernon Tool Co., Ltd.	96
Waukesha Motor Co.	
Wickwire Spencer Steel Co.	
W-K-M Company, Inc.	1
Youngstown Sheet & Tube Co.	4